This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

LANE MEDICAL LIBRARY STANFORD
2 45 0163 4807

C. S. Sargent M.D.

[illegible] Smith Bldg. [illegible]

1881

LANE
MEDICAL LIBRARY
SEAL OF THE LELAND STANFORD JUNIOR UNIVERSITY
1885
LEVI COOPER LANE FUND

LIBRARY
OF
COOPER MEDICAL COLLEGE
DATE Sept 1904
NO. 5625 CLASS 16
~~GIFT OF~~
Purchase

A. C. S. Sargent.

A. C. S. Sargent

[illegible]

C. S. Sargent M.D.
c/o Smith Bldg.-
Stockton
Cala

THE

PRINCIPLES AND PRACTICE

OF

OPERATIVE SURGERY.

BY

STEPHEN SMITH, A.M., M.D.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF THE CITY OF NEW YORK;
SURGEON TO THE BELLEVUE AND ST. VINCENT HOSPITALS, NEW YORK;
CONSULTING SURGEON TO ST. ELIZABETH'S HOSPITAL, TO THE FOUNDLING ASYLUM,
TO THE INFANTS' ASYLUM; ETC. ETC.

NEW AND THOROUGHLY REVISED EDITION.

ILLUSTRATED WITH ONE THOUSAND AND FIVE WOODCUTS.

LANE MEDICAL LIBRARY
5625
SAN FRANCISCO

PHILADELPHIA:
LEA BROTHERS & CO.
1887.

Entered according to the Act of Congress, in the year 1887, by
LEA BROTHERS & CO.,
in the Office of the Librarian of Congress. All rights reserved.

Collins Printing House,
705 Jayne Street.

WA32
S66
1887

PREFACE TO THE SECOND EDITION.

THIS work was first published in 1879, and although there have been repeatedly large issues since that date—eight in number, each being designated as an edition—no change whatever was made in the text during that time. This is, therefore, the second, and only revised, edition. Within the period 1879–86 the principles and practice of operative surgery have undergone so complete a revolution, that the term, "the new surgery," applied to the present practice, is not inappropriate. Not only have the principles governing the treatment of wounds been so modified as to render operations, formerly very fatal, safe and expedient, but the field has been so extended as to embrace a wide range of successful procedures for the cure of injuries and diseases hitherto regarded and treated as necessarily incurable. To render the treatise a proper exponent of the present state of surgical art has required, not only a complete revision of the former text, but such additions as would comprise the new methods and operations. This has been carefully performed, and the author has the satisfaction of believing that the work now embraces the latest advances in this department of knowledge, and that the details of the most approved antiseptic methods have been placed in such a light that they may be easily mastered and utilized by every practitioner.

In preparing the text relating to antiseptics, and their employment, the author has drawn freely upon the works on antiseptic treatment of wounds by Mr. W. WATSON CHEYNE, who illustrates Mr. LISTER's practice; upon the monograph of Dr. VICTOR R. v. HACKER, Directions for the Antiseptic Treatment of Wounds, as employed at Professor BILLROTH's Clinic, ably translated by Dr. FREDERIC W. TAYLOR, of Boston; and upon the records of Bellevue Hospital, where the practice of antiseptic surgery rigidly conforms to formulæ based on the latest established facts in antisepsis.

NEW YORK, 574 MADISON AVENUE,
December, 1886.

PREFACE TO THE FIRST EDITION.

THE Handbook of Surgical Operations, prepared by the writer in 1862, though specially designed for military practice, was received with much favor by the profession at large. The request has often been made, by both medical practitioners and students, that the plan of the work should be enlarged so as to include the general operations of surgery in civil practice. The present work is the result of an effort to realize that object within the limits assigned, namely, general operations in surgery, the organs of special sense being excluded. The arrangement of matter and the structure of the text require explanation: (1) In defining the qualifications of the surgeon no attempt is made to establish an ideal standard of excellence. On the contrary, the true estimate of his qualifications is found in the civil obligation which he assumes whenever he undertakes the care of any case. The discrimination which the common law makes of the relation of qualifications to time, place, and circumstances, is far more important and judicious than has ever been furnished by any professional code. (2) It follows that as conformity to the established principles of an art is a fundamental requirement of the civil obligation upon those who practise such art, a manual of this character should, as far as practicable, illustrate those principles. It has, therefore, been a constant effort to give to the text the highest degree of authority, by embodying the teachings of recognized authorities on every subject, so far as they conform to what is believed to be the present standard of surgical opinion and practice. And to the same end the various subjects have for the most part been submitted for revision to competent authority and received its sanction; where special importance is attached to such revision, the name of the person consulted appears in small capitals. New theories and methods are noticed in the leading text only so far as they are obviously correct, or are sanctioned by the weight of responsible names. (3) In order to economize space, the opinions, and, as far as practicable, the language of writers have been incorporated into a condensed, uniform text, due credit being given by marginal references to the names of the authors. The larger type is designed to embody the principles and practice now established by authority, whilst the smaller type is employed for explanatory or supplemental matter.

In the general treatment of subjects something more has been attempted than to give the mere formal details of operations. Forty years ago, the author[1] of the most popular and useful manual of operative surgery ever issued, remarked in the preface, that such a treatise, to satisfy all the requirements of the age, should for each operation discuss indications, exactly study the surgical anatomy, review all the proceedings, and after mature examination and judicious choice of the best, describe the manipulation with all the necessary details, point out the different methods of dressing, give a statistical account of successes and failures, and, finally, in autopsies seek the causes of death. Although it is quite impossible, in the limited space of a manual, to discuss these and the many new questions relating to operations, yet the suggestions of that eminent author have been constantly borne in mind, and as far as practicable followed. No stereotyped method of treating subjects has been pursued, but each has been considered in such manner as seemed best adapted to present all necessary facts in the most available form for the practitioner.

---

[1] J. F. Malgaigne.

The illustrations, though ordinary in kind, form an important feature of the work. They were selected for the purpose of illustrating special features in each case, and only such parts have been used as were essential for that object. They have been derived from many sources, as from the former work, from works on surgery, medical periodicals, and from manufacturers of instruments.[1] A large number were specially drawn for the work, some of which are original studies of the artist.[2] Due credit is given, as far as possible, to the source from which each was derived.

[1] Tiemann & Co.; Reynders & Co.; Codman & Shurtleff.

[2] W. C. W. Glazier, M.D.

CONTENTS.

I.

THE PRINCIPLES.

CHAPTER I.

THE CIVIL OBLIGATIONS OF THE SURGEON.

PAGE
I. The Requisite Qualifications of the Surgeon 18
II. The Care required in each Case 19
III. Good Judgment is based on Knowledge 19
IV. The Responsibility is Individual 19
V. Antisepsis imposes New Obligations 20

CHAPTER II.

THE PRINCIPLES OF ANTISEPTIC SURGERY. . . 22

CHAPTER III.

THE EXAMINATION OF THE PATIENT.

I. Diagnosis 25
II. Prognosis 27
III. The Decision as to an Operation 30

CHAPTER IV.

THE GENERAL PREPARATION FOR THE OPERATION.

I. The Preparation of the Patient 31
II. The Time for the Operation 32
III. The Place for the Operation 33
IV. The Selection of Instruments 34
V. Convalescence 38

CHAPTER V.

THE METHODS OF PREVENTION OF HEMORRHAGE.

I. Elastic Compression 39
II. Arterial Compression 40
III. Ligation 42

PAGE
IV. Tortion 44
V. Acupressure 44
VI. Constriction 46
VII. Cauterization 46
VIII. Reinjection of Blood 48

CHAPTER VI.

ANÆSTHETICS AND THEIR EMPLOYMENT.

I. General Anæsthesia 48
II. Local Anæsthesia 52

CHAPTER VII.

GENERAL RULES AS TO THE MANUAL OF THE OPERATION.

I. The Instruments required 56
II. Dissection 56

CHAPTER VIII.

THE EMERGENCIES LIABLE TO OCCUR.

I. Narcosis 59
II. Bleeding 62
III. Shock 62
IV. Air in the Veins 63

CHAPTER IX.

THE MATERIALS FOR DRESSING WOUNDS AND THEIR APPLICATION.

I. External Applications 65
II. Kinds of Suture 66
III. Bandages and their Uses 70
IV. The Forms of Plastic Apparatus 73

CHAPTER X.

THE APPLICATION OF THE PRINCIPLES OF ANTISEPTIC SURGERY.

I. Disinfection of the Air 76
II. Disinfection of the Operator, Assistants, and Patient . . . 76
III. Antiseptic Solutions to be Used in and about the Wound . . 78
IV. Materials to be Used in the Wound 79
V. The Immediate Dressings of Wounds 81
VI. The External Dressings of Wounds 83

CHAPTER XI.

THE CONDITIONS AND DETAILS OF AN ANTISEPTIC OPERATION.

I. The Arrangement of Materials 86
II. The Preparation of the Operator and Assistant 87
III. The Preparation of the Table and Patient 88
IV. The Operation 90

CHAPTER XII.

THE DETAILS OF ANTISEPTIC DRESSINGS OF WOUNDS.

PAGE
I. The Antiseptic Dressing of Closed Wounds 92
II. Wounds which are not to be Closed 93
III. Changing the Dressing 96
IV. Precautions in the Use of Antiseptic Agents 98
V. The Open Treatment of Wounds 99
VI. The Hot Water Treatment of Wounds 100

CHAPTER XIII.

THE PROGRESS OF THE REPAIR OF WOUNDS.

I. Indications as to the Progress of Repair 101
II. The Conditions of Normal Repair 102
III. The Occurrence of Hemorrhages 102
IV. Repair Interrupted by Gangrene 104
V. Inflammation Complicating Wounds 105
VI. Forms of Fever which may Occur 107
VII. Nervous Affections complicating the Healing 111

CHAPTER XIV.

THE CICATRIZATION OF WOUNDS.

I. The Process of Normal Cicatrization 114
II. Forms of Diseased Granulations 115
III. Morbid Conditions of the Cicatrix 118

II.

THE OSSEOUS SYSTEM.

THE BONES; THE JOINTS.

CHAPTER XV.

INJURIES OF BONES AND SPECIAL OPERATIONS.

I. Subcutaneous Fracture 121
II. Compound Fractures 139

CHAPTER XVI.

DISLOCATION OF BONES.

Bones of the Face 145
Bones of the Vertebræ 146
Bones of the Upper Extremity 146
Bones of the Lower Extremity 149

CHAPTER XVII.

DISEASES OF BONE AND SPECIAL OPERATIONS.

PAGE
I. Rickets 155
II. Tumors of Bone 156
III. Inflammation of Bone 160
IV. Caries of Bone 161
V. Necrosis of Bone 163
VI. Sequestrotomy 165

CHAPTER XVIII.

INJURIES OF JOINTS AND SPECIAL OPERATIONS.

I. Contusions 166
II. Wounds 166

CHAPTER XIX.

DISEASES OF THE JOINTS AND SPECIAL OPERATIONS.

I. Inflammation 167
II. Caries 169
III. Loose Bodies 182

CHAPTER XX.

THE RESECTION AND EXCISION OF BONES.

Bones and Joints of the Upper Extremities 190
Bones and Joints of the Lower Extremities 211
Bones of the Trunk 229
Bones of the Face 230
Osteoplasty 237
Osteotomy 237
Osteoclasis 237

III.

THE MUSCULAR SYSTEM.

THE MUSCLES; THE TENDONS; THE FASCIÆ; THE BURSÆ.

CHAPTER XXI.

INJURIES OF THE MUSCULAR SYSTEM AND SPECIAL OPERATIONS.

I. Muscles and Tendons 238
II. Bursæ 241

CHAPTER XXII.

DISEASES OF THE MUSCULAR SYSTEM AND SPECIAL OPERATIONS.

PAGE
I. Muscles and Tendons 241
II. Bursæ 244
III. Contraction 245

CHAPTER XXIII.

GENERAL OPERATIONS ON THE MUSCULAR SYSTEM.

I. Myotomy; Tenotomy; Fasciatomy 247

IV.

THE CIRCULATORY SYSTEM.

THE HEART; THE ARTERIES; THE CAPILLARIES; THE VEINS; THE LYMPHATICS.

CHAPTER XXIV.

THE INJURIES OF THE CIRCULATORY SYSTEM AND SPECIAL OPERATIONS.

I. Injuries of the Heart 257
II. Injuries of the Arteries 258
III. The Veins 260
IV. The Lymphatics 261
V. Artery and Vein 262

CHAPTER XXV.

DISEASES OF THE CIRCULATORY SYSTEM AND SPECIAL OPERATIONS.

I. The Heart 263
II. The Arteries 263
III. The Veins 268
IV. The Capillaries 275

CHAPTER XXVI.

GENERAL OPERATIONS ON THE CIRCULATORY SYSTEM.

I. The Heart 277
II. The Arteries 278
III. The Veins 322
IV. The Capillaries 326
V. The Lymphatic System 329

V.

THE NERVOUS SYSTEM.

THE BRAIN; THE SPINAL CORD; THE NERVES.

CHAPTER XXVII.

INJURIES AND DISEASES OF THE SKULL AND BRAIN.

PAGE

I. Injuries of the Skull 330
II Diseases of the Skull 332
III. Injuries of the Brain 333
IV. Diseases of the Brain 339

CHAPTER XXVIII.

TREPHINING THE SKULL AND EXPLORING THE BRAIN.

I. Cerebral Anatomy 344
II. Cerebral Localization 345
III. Cranio-Cerebral Topography 347
IV. Indications for Trephining 352
V. Contra-Indications to Trephining 352
VI. Indications as to Points where the Trephine should be Applied . 353
VII. The Operation of Trephining 355

CHAPTER XXIX.

INJURIES AND DISEASES OF THE SPINE.

I. Injuries of the Spine 357
II. Defects of the Spine 360

CHAPTER XXX.

INJURIES AND DISEASES OF THE NERVES.

I. Injuries of the Nerves 361
II. Diseases of the Nerves 363
III. The Nervous Constitution 365

CHAPTER XXXI.

GENERAL OPERATIONS ON THE NERVES.

Nerves of the Face, Head, and Neck 367
Nerves of the Upper Limb 369
Nerves of the Lower Limb 372

VI.

THE TEGUMENTARY SYSTEM.

THE SKIN; THE HAIR AND GLANDS; THE NAILS.

CHAPTER XXXII.

INJURIES AND DISEASES OF THE TEGUMENTARY SYSTEM.

PAGE
I. Injuries of the Skin 374
II. Diseases of the Skin 384
III. The Hair and Glands 392
IV. The Nail 393

CHAPTER XXXIII.

GENERAL OPERATIONS ON THE TEGUMENTARY SYSTEM.

I. The Skin 397

VII.

THE DIGESTIVE ORGANS.

CHAPTER XXXIV.

THE LIPS.

I. Wounds of the Lips 409
II. Congenital Defects of the Lips 409
III. Hypertrophy of the Lips 414
IV. Acquired Defects of the Lips 415

CHAPTER XXXV.

THE PALATE.

I. Congenital Defects 421
II. Contraction of Soft Palate 427
III. The Uvula 427

CHAPTER XXXVI.

THE ALVEOLAR PROCESS; THE SALIVARY GLANDS; THE TONSILS.

I. The Alveolar Processes 429
II. The Salivary Glands 433
III. The Tonsils 437

CHAPTER XXXVII.

THE TONGUE.

PAGE
I. Injuries and Diseases of the Tongue 440
II. Excision of the Tongue 443

CHAPTER XXXVIII.

THE PHARYNX ; THE ŒSOPHAGUS.

I. The Pharynx 449
II. The Œsophagus 451

CHAPTER XXXIX.

THE ABDOMEN.

I. The Abdominal Parietes 459
II. The Umbilicus 462
III. The Peritoneum 462
IV. General Operations on the Abdomen 467
V. Relation of the Viscera of the Abdomen to its Walls . . . 470

CHAPTER XL.

THE STOMACH.

I. The Cardia 471
II. The Stomach Proper 472
III. The Pylorus 483

CHAPTER XLI.

THE DUODENUM ; THE JEJUNUM ; THE ILEUM.

I. The Duodenum 488
II. The Jejunum and Ileum 489

CHAPTER XLII.

THE CÆCUM ; THE COLON.

I. The Cæcum 504
II. The Colon 508

CHAPTER XLIII.

THE RECTUM 514

CHAPTER XLIV.

THE ANUS 524

CHAPTER XLV.

THE LIVER; GALL BLADDER; THE PANCREAS; THE SPLEEN.

PAGE
I. The Liver 583
II. The Gall Bladder 537
III. The Pancreas 540
IV. The Spleen 543

CHAPTER XLVI.

THE HERNIÆ OF THE ABDOMEN.

I. General Characters of a Hernia 545
II. Different Forms of Hernia 546
III. The Palliative Treatment of Hernia 553
IV. The Radical Treatment of Hernia 556
V. Strangulated Hernia 566

VIII.

THE RESPIRATORY ORGANS.

CHAPTER XLVII.

THE NOSE; THE NASAL FOSSÆ; THE ANTRUM.

I. The Nose 578
II. The Nasal Fossæ 583
III. The Antrum 595

CHAPTER XLVIII.

THE LARYNX 596

CHAPTER XLIX.

THE TRACHEA; THE THYROID BODY; THE BRONCHI.

I. The Trachea 612
II. The Thyroid Body 621
III. The Bronchi 623

CHAPTER L.

THE LUNGS 624

IX.

THE URINARY ORGANS.

THE KIDNEYS; THE URETERS; THE URINARY BLADDER; THE URETHRA.

CHAPTER LI.

PAGE
I. The Kidneys 633
II. The Ureters 646

CHAPTER LII.

THE URINARY BLADDER.

I. Exploration 648
II. Malformation 650
III. Injuries 652
IV. Inflammation 653
V. Retention of Urine 655
VI. Tumors of the Bladder 655
VII. Foreign Bodies 657

CHAPTER LIII.

URINARY CALCULUS.

I. Litholapaxy 659
II. Lithotomy 667
III. Peritoneal Lithotrity 675
IV. Vesical Calculus in Women 676

CHAPTER LIV.

THE URETHRA.

I. The Exploration 677
II. Defects of Urethra 679
III. Injuries 683
IV. Foreign bodies 684
V. Stricture 686
VI. Internal and External Perineal Urethrotomy 692
VII. Retention of Urine 694
VIII. The Female Urethra 695

X.

THE ORGANS OF GENERATION.

THE MALE ORGANS.

CHAPTER LV.

THE TESTICLES.

PAGE
I. The Scrotum 697
II. The Spermatic Cord 700
III. The Testis 701

CHAPTER LVI.

THE PROSTATE GLAND 704

CHAPTER LVII.

THE PENIS 710

THE FEMALE ORGANS.

CHAPTER LVIII.

THE UTERINE APPENDAGES.

I. The Ovaries 716
II. The Fallopian Tubes 725
III. The Parovarium 726

CHAPTER LIX.

THE UTERUS 726

CHAPTER LX.

THE VAGINA.

I. Exploration of Vagina 740

CHAPTER LXI.

THE VULVA.

Vulvar and Vaginal Enterocele 756

CHAPTER LXII.

THE MAMMARY GLANDS 759

XI.

THE EXTREMITIES.

CHAPTER LXIII.

AMPUTATION.

PAGE
I. Amputations of the Hand 772
II. Amputation of the Forearm 782
III. Amputation at the Elbow-Joint 783
IV. Amputation of the Arm 785
V. Amputation at the Shoulder-Joint 786
VI. Amputation of the Foot 790
VII. Amputation at the Ankle-Joint 799
VIII. Amputation of the Leg 804
IX. Amputation at the Knee-Joint 807
X. Amputation of Thigh 811
XI. Disarticulation at the Hip-Joint 813

XII.

ORTHOPÆDIA.

CHAPTER LXIV.

I. The Spinal Column 817
II. Deformities of the Hand 822
III. Distortions of the Feet 823
IV. Malposition after Fracture 831
V. Curvatures at the Knee 832

CHAPTER LXV.

ANCHYLOSIS 836

CHAPTER LXVI.

COMPENSATIVE APPLIANCES.

I. Pseudarthrosis 845
II. Paralysis 848
III. Dangle Limbs 850
IV. Artificial Limbs 851

LIST OF ILLUSTRATIONS.

FIG.		PAGE
1.	General antiseptic operating bag	36
2.	Bottle for antiseptics	37
3.	Full set of aseptic knives and two handles	37
4.	Compact pocket-case	37
5.	Elastic bandage	39
6.	Elastic bandage applied	39
7.	Digital compression	41
8.	Tourniquets	41
9.	Tourniquet applied	41
10.	Tenaculum	42
11.	Artery forceps	42
12.	Artery forceps with slide	42
13.	Tying an artery	43
14.	Catch forceps	43
15.	A variety of forceps	43
16.	Surgeon's knot	43
17.	Sailor's knot	44
18.	Inclosing tissues	44
19.	Tortion applied	44
20.	Direct acupressure	45
21.	Acupressure by torsion	45
22.	Different modes of applying acupressure	45
23, 24.	Acupressure forceps	46
25.	Artery constrictor	46
26.	Cauteries	47
27.	Paquelin's cautery	47
28.	Inhaler	49
29.	Apparatus for etherization by rectum	52
30.	Hand spray	53
31.	Elastic bandage	54
32.	Hypodermic syringe	54
33.	Bandage with clamp	55
34.	Clamp	55
35.	Bandage on limb	55
36.	Isolating ring	55
37.	Isolating forceps	55
38.	First position	57
39.	Second position	57
40.	Third position	57
41.	Fourth position	57
42.	Pushing the jaw forward	59
43.	First position	60
44.	Second position	61
45.	How to do it; how not to do it	66
46.	Ordinary needles	66
47.	Needle holders	66
48.	Wounds of new needle	67
49.	Needles for external wounds	67
50, 51.	Needles for intestines and plastic wounds	67
52.	Needle holder	67
53.	Mounted needle, armed with ligature	68
54.	Continuous suture	68
55.	Double thread suture	68
56, 57.	Suture of relaxation and coaptation	68
58.	Twisted suture	69
59.	Quilled suture	69
60.	Button sutures	69
61.	Suture of relaxation	69
62.	Single head	70
63.	Circular	71
64, 65.	Spiral	71
66.	Spica	72
67, 68.	Figure-of-eight	72
69.	Double head	72
70.	Recurrent	73
71.	The T	73
72.	Bandage for head	73
73.	Plastic bandage shears	75
74.	Antiseptic ligatures	79
75.	Drain tube	80
76.	Loosely bandaged gauze dressing, and gutta-percha tissue	85
77.	Contrast of the limb prepared for the operation with its fellow	88
78.	Leg arranged for excision of knee-joint	89
79.	Use of catch forceps	90
80.	Arrangements for antiseptic operation	91
81.	Wound closed and drained	92
82.	Skin grafting scissors	117

FIG. PAGE
83. Growing skin grafts . . . 117
84. Fracture of the lower jaw . 122
85. Cap for chin 122
86. Four-tailed bandage . . . 122
87. Plaster-of-Paris apparatus . 123
88. Apparatus in fracture . . 123
89. Strapping in fractured ribs . 124
90. Dressing for fractured clavicle. 125
91. First adhesive strip . . 125
92. Second adhesive strip . . 125
93. Fracture of head of tuberosities. 126
94. Separation of shaft of humerus from upper epiphysis . 126
95. Fracture at the surgical neck 127
96. Comminuted fracture of condyles 127
97. Dressing of fractured humerus 127
98. Dressing of fracture of olecranon 128
99. Colles fracture—side view . 129
100. Colles fracture — posterior view 129
101. Position of the fragments . 129
102. Position of strips on the splints 130
103. Dressing completed . . 130
104. Methods of determining position of head of femur . 131
105. Application of adhesive strips 132
106. Pulley and weights . . 132
107. Complete apparatus for fracture of the thigh . . 133
108. Apparatus of plaster-of-Paris for fracture of the thigh 134
109. Apparatus for fracture of femur in children . . 134
110. Position with limbs suspended 134
111. Fracture of patella . . 135
112. Fracture of tibia . . . 137
113. Fracture of fibula . . . 137
114. Gypsum dressing for fracture of tibia and fibula . 138
115. Stromeyer's cushion pad . 142
116. Suspension apparatus . . 142
117. Gypsum splint for fracture of femur 143
118. Wooden frame 144
119. Wire suspension apparatus . 144
120. Suspension of leg . . . 144
121. Clove-hitch 145
122. Reduction of lower jaw . 146
123. First position . . . 147
124. Second position . . . 147
125. On dorsum 149
126. Toward ischiatic notch . 149
127. Into foramen ovale . . 149
128. Upon pubes 149
129. Head below the obturator tendon 150
130. Head on lower margin of acetabulum . . . 150
131. Head in perineum . . 150
132. Reduction by manipulation 151
133. Lifting the head of the bone 152
134. Method of reducing dislocation of the hip backwards 152
135. Reduction by manipulation 153
136. Dorsal dislocation . . 153
137. Apparatus for rickets . . 156
138. Chondromata of fingers . 157
139. Exostosis 158
140. Periosteal osteo-sarcoma . 159
141. Myeloid tumor of radius . 159
142. Abscess in head of tibia . 162
143. Early dorsal caries . . 172
144. Attitude of child in angular curvature . . . 172
145. Application of Sayre's plaster jacket . . . 173
146. Jacket applied . . . 174
147. Finestra over curvature . 174
148. Finestra over stomach . 174
149. Plaster dressing for cervical caries 175
150. Jury mast 175
151. Apparatus for disease of spine 175
152. Spinal brace . . . 176
153. Appearance of hip when disease is advancing . 177
154. Position of leg when spine is straight 178
155. Curvature of spine when leg is straight . . . 178
156. Hip splint 179
157. Hip splint applied . . 179
158. Knee extending splint . 180
159. Splint applied . . . 180
160. Gypsum splint . . . 180
161. Steel brace. Apparatus applied 181
162. Gypsum apparatus . . 181
163, 164. Scalpels . . . 184
165. Retractor 184
166, 167. Periosteotomes . . 184
168–172. Cutting forceps . . 185
173. Chain saw 185
174. Saw with movable back . 185
175, 176. Right and left saws . 186
177. Straight-back saw . . 186
178. Hey's saw 186

FIG. PAGE
179. Butcher's saw . . . 186
180. Drills 187
181, 182. Adjustable handle . 187
183–186. Forceps . . . 187
187. Bone scoop . . . 188
188. Combined forceps and saws 188
189. Resection of metacarpal bone 191
190. Resection of the proximal end 192
191. Resection of distal end . 192
192. Excision of metacarpo-phalangeal joint . . . 192
193. Excision of wrist . . 194
194. Hand after excision of wrist 196
195. Resection of lower end of radius 197
196. Arm from which radius has been removed . . . 197
197. Resection of lower end of ulna 198
198. Excision of extremities of radius and ulna . . 199
199. Excision of elbow . . 201
200. Methods of Van Langenbeck and Ollier . . . 202
201. Methods of Nélaton and Hüter 202
202. Osteoplastic method . . 202
203. Method of Bigelow . . 203
204. Resection of lower end of humerus 204
205. Resection of upper end of humerus 205
206. Excision by straight incision 206
207. Excision of the shoulder . 206
208. Excision of scapula . . 208
209. Resection of sternal end of clavicle 210
210. Resection of metatarsal bone 211
211. Synovial membrane . . 212
212, 213. Resection of cuneiform bones 213
214. Excision of the astragalus . 214
215. Excision of the os calcis . 215
216. Disease of the os calcis . 215
217, 218. Resection of tarsal bones and excision of ankle-joint 217
219. Suspension splint . . 217
220. Leg suspended . . . 217
221. Osteoplastic excision of the foot 218
222. Resection of lower end of fibula 219
223. Excision of knee . . 222
224. Different lines of excision . 222
225. Methods of excision . . 223
226. Suspension of leg . . 224
227. Excision of the hip . . 226
228. Passing chain saw . . 227
229. Von Langenbeck's method . 228
230. Dressing in hip-joint abscess 228
231. Hip splint 229
232. Excision of half of lower jaw 233
233, 234. Lines for resection of upper jaw . . . 234
235. Resection of upper jaw . 235
236. Atrophy of capsular muscles of shoulders . . . 238
237. Ruptured long tendon of biceps 239
238. Strap for rupture of the tendo Achillis . . . 241
239. Ganglion involving all the flexor tendons of the hand and wrist . . . 243
240. Malignant tumor in sole . 243
241. Section of foot, showing section of tumor . . . 243
242. Palmar fascia contraction . 246
243. Tenotomes 248
244. Narrow blade . . . 248
245. Dividing tendo Achillis . 249
246. Division of sterno-cleido . 256
247. Compress for artery . . 259
248, 249. Different forms of varicose aneurism . . . 262
250. Two compressors applied for femoro-popliteal aneurism 268
251. Varicose veins . . . 269
252. Internal hæmorrhoids . 270
253. Ligature forceps . . 271
254. Clamp for hæmorrhoids . 272
255. Straight needles in handles 273
256. First position of needle . 273
257. Showing second position of needle 273
258. Loop around spermatic vessels 274
259. Large nævus of upper lip . 275
260. Subcutaneous ligature of nævus 276
261. Ligature of a mixed nævus 276
262. Ligature of nævus . . 276
263. Incisions for ligature . . 276
264. An elongated nævus . . 276
265. Diagram showing the different operations for aneurism 279
266. Aneurism needle . . 280
267. Needles for deep ligations . 280
268. Artery hook and handle for needle 280
269. Opening the sheath . . 281
270. Cleaning the artery . . 282
271. Passing the needle; first stage 282

FIG. PAGE
272. Passing the needle ; second stage 282
273. Tying the knot . . . 283
274. Innominate artery . . 285
275. Subclavian and common carotid arteries . . . 285
276. Common carotid; first part 286
277. Common carotid below omo-hyoid 287
278. Diagram of the right common carotid artery at the seat of ligature . . 288
279. Diagram of the carotid sheath 288
280. Anatomical relations of the lingual and facial arteries 290
281. The facial and temporal arteries 291
282. Occipital artery . . . 292
283. Subclavian artery . . 296
284. Diagram of the right subclavian artery . . . 297
285. Axillary artery . . . 298
286. Diagram of the ligature of the right axillary artery . 298
287. Axillary artery below the clavicle 299
288. Diagram of ligature of the axillary artery . . 299
289. Ligature of brachial artery . 300
290. Transverse section of the arm at its middle . . . 301
291. Diagram of the parts concerned in ligature of the brachial in the middle of the arm 301
292. Brachial artery in the middle of the arm . . . 302
293. Brachial artery at the elbow 302
294. Ligature of radial artery . 303
295. Ligature of radial artery in its lower third . . . 303
296. Radial artery of the wrist . 304
297. The ulnar artery in its upper third 304
298. Ligature of the radial and ulnar arteries of the lower third 305
299. Ulnar artery at the wrist . 305
300. Position and mode of formation of the palmar arch . 306
301. Method of finding the position of the superior palmar arch 306
302. Dissection of the common iliac 308
303. Position and direction of the superficial incisions . . 310

FIG. PAG
304. Ligature of gluteal artery . 310
305. Ligature of sciatic artery . 311
306. Ligature of internal pudic artery 311
307. Ligature of external iliac and superficial femoral arteries 312
308. Common femoral artery . 314
309. Femoral artery in Scarpa's space 315
310. Diagram of the left femoral artery 315
311. Diagram of ligature of the left femoral artery . . 315
312. Hunter's canal . . . 316
313. Diagram of left popliteal artery 316
314. Popliteal artery . . . 317
315. Popliteal artery below the internal condyle . . 317
316. Transverse section of the leg, upper third . . 318
317. Ligature of the posterior tibial artery . . . 319
318. Ligature of posterior tibial artery behind inner malleolus 319
319. Anterior tibial artery in its middle third . . . 320
320. Ligature of dorsalis pedis artery 321
321. Venesection . . . 322
322. Transfusion of a bulb tube . 323
323. Transfusion by a pump . 323
324. Opening a vein . . . 324
325. Apparatus for injecting saline mixtures . . . 325
326, 327. Artificial leeches . . 327
328. Scarificator . . . 328
329. Cup and suction pump . 328
330. Pump with adjustable receiver 328
331. An elastic bulb . . . 328
332. Lymphadenoma of glands at root of neck . . . 329
333. Drawing showing clot . . 335
334. Meningocele . . . 343
335. Meningocele at root of nose 343
336. Fissure of Sylvius . . 345
337. Diagram of the exterior of the skull . . . 348
338. Topography of the fissure of brain 349
339. Topography of convolutions of brain 350
340. Situations in which the trephine may be applied . 353
341. Instruments for trephining . 355
342. The middle meningeal artery 356

FIG. PAGE
343. Application of trephine . 356
344. Removing projecting bone with rongeur . . . 356
345. Inability to stoop in strain of the back 358
346. Large spina bifida . . 360
347. Congenital coccygeal tumor 361
348. Nerves of the face . . 367
349. Resection of brachial plexus 370
350. Anterior nerves of arm . 371
351. Posterior nerves of arm . 371
352. Posterior nerves of leg . 372
353. Anterior nerves of leg . 373
354. Gunshot wound. Aperture of entry 377
355. Gunshot wound. Aperture of exit 377
356, 357. Bullet probes and forceps 378
358. Missiles seized by forceps . 379
359. Structure of a corn . . 385
360. Opening an abscess . . 386
361. Rodent cancer of face . 390
362. Rodent ulcer of back of hand 390
363. Pachydermatous tumor of the scalp . . . 391
364. Growth of hairs . . . 392
365, 366. Distension of sebaceous glands 393
367. Lipoma of nose . . . 393
368, 369. Removal of the nail . 395
370. Acute onychia . . . 395
371. Chronic onychia . . 395
372. Horny growth from beneath the nail 396
373. Ungual exostosis . . 396
374. Thermometers . . . 397
375. Clinical thermometer . . 397
376. Thermoscope . . . 398
377. Acupuncture needles . . 400
378. Seton needle . . . 400
379. Puncture for seton in the neck 400
380. Seton on a probe . . 400
381. Cauteries 401
382. Hypodermic syringe and needles 401
383. Introduction of hypodermic syringe 402
384. Excision of cicatrix . . 406
385. Closing of wound after removal of cicatrix . . . 406
386. Cicatrix after burn of neck . 407
387. Removal of cicatrix . . 408
388. Application of twisted suture 409
389. Development of the intermaxillary . . . 409
390. Harelip congenital cicatrix . 409
FIG. PAGE
391. Harelip as slight notch . 409
392. Harelip as deep fissure on right side . . . 410
393. Uncomplicated double harelip 410
394. Operation for harelip . . 410
395. Hainsby's truss . . . 411
396. Apparatus for drawing forward the cheeks in harelip operation . . . 411
397, 398. Nélaton's operation for partial harelip . . 411
399. Operation for single harelip 411
400, 401. Collis's operation for harelip 412
402. Malgaigne's operation for harelip 412
403, 404. Harelip . . . 412
405, 406. Double harelip . . 413
407. Before operation . . 414
408. Front view . . . 414
409. Side view 414
410. Hypertrophy of mucous glands of lips . . . 414
411. Hypertrophy of lip . . 414
412. V-incision wound closed with twisted suture . . . 415
413–415. Buchanan's operation for restoration of lower lip 415
416, 417. Syme's method of restoring lower lip . . 416
418. The quadrilateral flap . 416
419. Operation for loss of cheek and lower lip . . . 417
420, 421. Operation for loss of lower lip and chin . . 417
422. Operation for loss of upper lip and cheek . . . 418
423. Restoration of angle of lower lip 418
424. Loss of right half of upper lip 419
425. Extending angle of the mouth 419
426. Loss of upper lip and nose 419
427. Result of first operation . 420
428. Result of second operation . 420
429. Operation for loss of upper lip and part of the nose . 420
430. Instruments for the palate . 421
431. Mouth gag . . . 422
432. Slight fissure . . . 422
433. Large fissure . . . 422
434. Fissure of soft and hard palate 422
435. Whitehead's gag and tongue depressor . . . 423
436. Fissure showing the paring of the edges . . . 423
437. Passing the suture . . 424

FIG. PAGE
438. Sédillot's operation for staphyloraphy . . . 424
439. Incisions to relieve tension . 424
440, 441. Puncture with awl to give line for chisel . . 426
442. Contraction of soft palate . 427
443. Uvula instruments . . 428
444. Uvula forceps . . . 428
445. Epulis of lower jaw . . 429
446. Front view of tumor of alveolus 430
447. Section of odontone . . 430
448. Dentigerous tumor of jaw . 431
449. Canine tooth as seen in a case of dentigerous cyst . 431
450. Forceps for extraction of teeth 432
451. Manner of holding forceps . 432
452. Antrum perforator . . 433
453. Gimlet 433
454. Ranula; introduction of seton 435
455. Tonsil instruments . . 437
456. Automatic tonsillitome . 439
457. Hypertrophy of the tongue . 441
458. Écraseur 445
459. Galvano-cautery . . 445
460. Different operations for removal of the tongue . 446
461. Removal of tongue with écraseur 447
462. Tongue drawn out between the jaw and hyoid bone . 447
463. Removal of the tongue . 448
464. Pharyngeal mirror . . 449
465. Self-acting spatula . . 449
466. Pharyngeal forceps . . 450
467. Bristle probang . . . 450
468. Probangs 450
469. Introduction of tube through the nose 451
470. Irregular curved forceps . 452
471. Probang forceps . . 452
472. Right-angled forceps . . 452
478. Hooks for extracting coins . 453
474. Œsophageal dilators . . 454
475. Œsophagotome . . . 455
476. Olive-shaped œsophageal explorer 456
477. Œsophagotomy . . . 456
478. Trocar and canula . . 463
479. Tapping the abdomen . . 464
480. Abdominal sectional lines of incision 467
481. Section through abdominal wall and dressing . . 469
482. The abdominal viscera *in situ* 470
483. Stomach-pump . . . 472

FIG. PAGE
484. Bulb stomach-pump . . 472
485. Stomach tube . . . 473
486. Dilator of jaw . . . 473
487. Continuous suture . . 474
488, 489. Lembert's suture . 475
490. Filling the stomach . . 477
491. Emptying the stomach . 477
492. Compound syphon . . 477
493. Opening stomach . . 480
494, 495, 496. Suture of stomach wound 481
497. Supplying masticated food to stomach . . . 481
498. Rupture of the duodenum near junction of jejunum 488
499. Rupture of the serous and muscular coats of intestine 490
500. Rupture of intestine . . 490
501. Stab wounds of bowel closed by suture . . . 492
502. Lembert's suture . . 492
503. Application of suture to wounded bowel . . 492
504. Lembert's suture, including peritoneal coat of intestine alone 493
505. Czerney's suture . . 493
506. Gegenbauer's suture . . 493
507. Jobert's suture for complete transverse division of the intestine . . . 494
508. Suture tightened . . 494
509. Double suture . . . 494
510. Intestine sutured . . 494
511. The ileum, showing ten perforations . . . 495
512. Intussusception . . . 496
513. Strangulation of the bowel 499
514. Inguinal wound made in Nélaton's operation of enterotomy 501
515. Mode of securing bowel before opening it . . 502
516. Plan of curing artificial anus 503
517. Enterotome . . . 503
518. Enterotome applied . . 503
519. Intussusception of cæcum . 507
520. Rectal tubes . . . 510
521. Line of incision in lumbar colotomy . . . 512
522. Bowel united to external wound 513
523. Rectal speculums . . 515
524. Common syringe . . 516
525. Bulb syringe . . . 516
526. Elastic air bulb syringe . 516
527. Rectum dilator . . . 519
528. Prolapsus recti . . . 520

FIG. PAGE
529. Imperforate anus . . . 526
530. Incision for imperforate anus 526
531. Bowel attached to external wound 526
532. Vaginal fistula . . . 527
533. Colotomy on right side . 528
534. Stretching the sphincter . 530
535. External fistula . . . 530
536. Internal fistula . . . 530
537. Complete fistula . . . 530
538. Operation for fistula in ano . 532
539. Incising fistula . . . 532
540. Director brought out of anus 532
541. Application of ligature . 532
542. Tying ligature . . . 532
543. Abscess of liver . . . 536
544. Incision of the cyst . . 543
545. Position of abdominal rings 545
546. Femoral and internal abdominal rings . . . 547
547. Diagram of the inguinal canal 547
548. Oblique inguinal hernia . 548
549. Direct inguinal hernia . 548
550. Congenital inguinal hernia . 549
551. Infantile hernia . . . 549
552. Encysted form of infantile hernia 549
553. Common scrotal hernia . 549
554. Cysts of the cord . . 550
555. Hernia into the funicular process 550
556. Femoral artery and vein . 550
557. Femoral hernia . . . 551
558. Fascia at umbilicus . . 552
559. Congenital umbilical hernia 552
560, 561. Band and pad applied 554
562, 563. Two pads applied . 554
564. Trusses 554
565. Truss applied . . . 555
566. Horseshoe pad . . . 555
567. Umbilical truss . . . 556
568. Knife and needle for radical cure of hernia . . . 558
569. Operation for the radical cure of hernia . . . 558
570. Making the third puncture . 559
571. Radical cure of large hernia 559
572. Radical cure of inguinal hernia 560
573. Wires twisted . . . 560
574, 575. Radical cure of femoral hernia 561
576, 577. Radical cure of umbilical hernia . . 562, 563
578. Passing the second wire . 563
579. Passing the second ends of the wires . . . 563
580. Radical cure of umbilical hernia—wires in place . 563
581. Pins used for the radical cure of hernia . . . 564
582. Introducing the pin . . 564
583. The pins in place . . 565
584. A strangulated hernia . 567
585. Reduction of the sac of a hernia 568
586. Neck of the hernial sac . 568
587. Subperitoneal connective tissue 568
588. Resection of gangrenous bowel 570
589. Probe-pointed bistoury . 571
590. Incision for strangulated inguinal hernia . . . 571
591. Operation for hernia . . 572
592. Dissection of hernia . . 572
593. Introduction of director . 572
594. Finger as a director in operation for hernia . . 573
595. Incision for inguinal hernia 574
596. Dressing in hernia cases . 574
597. Incision for strangulated femoral hernia . . . 575
598. Spica bandage . . . 576
599. Variations in origin and course of obturator artery 576
600. Incision in operation for umbilical hernia . . . 577
601. Restoration of apex of nose . 578
602. Deficiency of ala of the nose 579
603. Diagram of flap in rhinoplastic operation . . . 579
604. Depressed nose . . . 580
605. New nose day after operation 580
606. Rhinoplasty 581
607. Sunken nose. Double layer . 581
608. Closure of fistula of meatus . 582
609. Closure of foramen . . 582
610. Shaping mouth . . . 582
611. Foramen closed and mouth shaped 582
612. Nasal instruments . . 583
613. Türk's tongue depressor . 583
614. Posterior rhinoscopy . . 584
615. Reflecting mirror . . 584
616. Laryngoscope . . . 584
617. Hand spray . . . 585
618. Sass spray tubes . . 585
619. Nasal douche . . . 586
620. Insufflator 586
621. Rubber tube . . . 587
622. Hard rubber laryngeal and posterior nares syringe . 587
623. Nasal splints . . . 587
624. Catheter tube . . . 589

FIG. PAGE
625. Diagram of plugging the nostril by means of Bellocq's sound 589
626, 627. Polypus forceps . . 591
628. Removal of nasal polypus by noose 592
629. Nasal écraseur . . . 592
630. Incisions for fibrous polypi . 593
631. Excision for fibrous polypi . 594
632. Laryngeal mirror . . 597
633, 634. Examination of larynx with mirror . . . 597
635. Examination with reflector . 598
636. Caustic holder . . . 598
637. Concealed caustic holder . 598
638. Laryngeal brush . . . 598
639. Insufflator 598
640. Sponge-holders . . . 599
641. Laryngeal syringe . . 599
642. Steam atomizer . . . 599
643. Incision in laryngotomy . 603
644. Position of patient in laryngotomy 603
645. Double tracheal tube . . 603
646. Laryngeal forceps . . 603
647. Appliances used by Schroetter in dilating stenosis of the larynx . . . 604
648. Mackenzie's laryngeal dilator 605
649. Form of instrument for scarification 605
650. Ring scarificator . . 605
651. Laryngeal knives . . 607
652. Laryngeal scissors . . 607
653. Laryngeal scissors . . 607
654. Curved and guarded bistoury 608
655. Tampon canula . . . 609
656. O'Dwyer's mouth-gag . 611
657. O'Dwyer's introducer . 611
658. O'Dwyer's extractor . . 612
659. The trachea . . . 612
660. Tracheotomes . . . 614
661. Broad-beaked forceps . . 615
662. Flexible forceps . . . 615
663–665. Tracheotomy tubes . 616
666. Fuller's bivalve tube closed . 616
667, 668. Bivalve tube with canula introduced . . . 616
669. Forceps 617
670. Grooved spatula . . . 617
671. Grooved forceps . . . 617
672. Double hooks . . . 617
673. Pilot trocar . . . 617
674. Trocar and canula . . 626
675. Points for tapping . . 627
676. Drainage tube for pleural cavity 628
677. Relative position of kidneys to front surface of abdomen 633
678. Relative position of kidneys to posterior surface of body 633
679. Incision for perinephritic abscess 637
680. Aspirator 641
681. Gum-elastic catheters . . 648
682. Catheterism . . . 649
683. Sounds 650
684. Wood's operation for extroverted bladder . . 651
685. Wood's operation; flaps applied 651
686, 687. Bigelow's operation . 651
688. Mode of washing out the bladder 654
689. Lithotrite 657
690. Jaws of Bigelow's lithotrite, shut 660
691. Jaws of Bigelow's lithotrite, open 660
692. Handles of Bigelow's lithotrite, shut . . . 660
693. Handles of Bigelow's lithotrite, open . . . 660
694. Keyes's fenestrated lithotrite 661
695. Bigelow's straight and curved catheter 662
696. Introduction of the lithotrite 662
697. Bigelow's evacuator with an elastic bulb . . . 663
698. Evacuator in action . . 664
699. Method of seizing the stone behind the prostate . . 665
700. Removal of fragments of stone by Bigelow's evacuator 666
701. "Shirted canula" . . 668
702. Grooved staff . . . 668
703. Beaked bistoury . . 668
704. Straight forceps . . . 668
705. Curved forceps . . . 668
706. Scoop 668
707. Position of patient and line of incision in lateral lithotomy 668
708. Lithotomy bracelets . . 669
709. Arteries of perineum and deep fascia . . . 669
710. Lateral lithotomy . . 670
711. Lateral lithotomy with curved staff 670
712. Incision in prostate . . 671
713. Staff 672
714. Grooved staff . . . 672
715. Directors 673

FIG. PAGE
716. Incisions in lithotomy . . 673
717. Apparatus for distending the rectum collapsed and distended 674
718. Dilator 675
719. Dilator applied . . . 675
720. Lithoclast 676
721. Urethra-meter . . . 678
722. Endoscope . . . 678
723. Meatoscope . . . 678
724. Soft catheters . . . 679
725. Hypospadias . . . 679
726. Operation for hypospadias . 679
727. 728. Urethroplasty . . 680
729. Operations for perineo-scrotal hypospadias . . 681
730, 731, 732. Operation for large fistula 682
733. Urethroplasty in small fistula 682
734. Epispadia 683
735. Long urethral forceps . . 684
736. Short urethral forceps . 684
737. Trilabe forceps . . . 685
738. Urethral scoop . . . 685
739, 740, 741, 742. Urethral scoops and their application 685
743. Fixed scoop . . . 685
744. Fixing stone upon the scoop 685
745, 746. Bulbous bougies . . 687
747. Tunnelled divulsor . . 690
748. Lateral divulsor . . . 690
749. Urethrotome . . . 691
750. Filiform bougies . . 692
751. Tunnelled sound . . 692
752. Tunnelled urethrotome . 693
753. Operation of puncturing the bladder per rectum . . 695
754. Elephantiasis of the scrotum 698
755. Henry's serrated clamp . 699
756. Tapping the hydrocele . 700
757. Encysted hydrocele of the cord 700
758, 759. Different methods of strapping testicle . . 702
760. Hypertrophy of both lobes of prostate . . . 705
761. Enlargement of the third lobe of the prostate . . 705
762. Reginald Harrison's dilators 706
763. Passage maintained by bougie 707
764. Single elbow catheter . . 708
765. Double elbow catheter . 708
766. Prostatic guide with spiral shaft 708
767. Bladder laid open . . 709
768. Enlarged middle lobe of prostate 709
769. Irritated congenital phimosis 711
770. Circumcision in the adult . 711
771, 772. Preparation of flaps . 712
773. Ross's circumcision ring . 712
774, 775. Reduction of paraphimosis 713
776. Mode of dividing prepuce in paraphimosis . . . 713
777. Warts on the glans and inner surface of prepuce . . 714
778. Epithelioma of the penis . 714
779. Stump of penis after operation 715
780. Trocar and canula . . 719
781. Wells's trocar . . . 722
782. Emmet's trocar . . . 722
783. Staffordshire knot . . 722
784. Clamp for pedicle . . 724
785. The wire-clamp . . . 725
786. Uterine sounds . . . 727
787. Hysterotome . . . 727
788. Laceration of the cervix . 731
789. Cicatricial plug in the lacerated cervix . . . 732
790. Cicatricial hypertrophy after laceration . . . 733
791. Diagram of surfaces to be denuded 733
792. Double tenaculum, separating the flaps of a laceration 733
793. Lacerated cervix after denudation 734
794, 795, 796. Vaginal specula . 740
797. Single valve speculum . 741
798. Gynecological table . . 741
799. Toothed forceps . . . 742
800. Tenaculum . . . 742
801. Curved scissors . . . 742
802. Paring edges of vaginal fistula 743
803. Needle forceps . . . 743
804. Applying counter pressure 744
805. Using the feeder in introducing sutures . . . 744
806. Introducing wire suture . 744
807. Wires cut off . . . 744
808. Shield 744
809. Twisting a suture . . 745
810. Shouldering sutures . . 745
811. Flattening the sutures to the vaginal surface . . 745
812. Sigmoid catheter . . 745
813. Diagram showing the surfaces united when diminishing the size of the vaginal outlet . . . 749

FIG. PAGE
814. Diagram showing the direction of the sutures . . 750
815. Emmet's operation for diminishing the vaginal outlet by external sutures . 750
816. Method of securing the ends of the sutures . . . 751
817. Retraction of fibres after rupture of the muscles . 752
818. Parts dissected . . . 753
819. Diagram showing faulty introduction of sutures . 753
820. Diagram showing proper introduction of sutures . 753
821. Complete perineal rupture 754
822. Anal fistula and labio-rectal fistula 755
823. End of anal, labial, and perineal ligatures . . 755
824. Labial orifices of abscess, and rectal opening . . 755
825. Pudendal hernia . . 758
826. Result of operation . . 758
827. Strapping breast . . 760
828, 829. Excision of breast . 762
830. Incisions clearing axilla . 763
831. Excision of the breast . 763
832. Back dressing ready for application . . . 764
833. Dressings applied after excision of mamma . . 765
834. Dressing in cases of operation on the axilla alone . 765
835. Antiseptic knives . . 767
836. Amputation saw . . 768
837. Amputation by circular method 769
838. Circular amputation . . 770
839. Double-flap amputation . 770
840. Lines of incision in Teale's amputation . . . 770
841. Teale's amputation; stump 771
842. Flaps of skin and circular incision of muscles . . 771
843. Method of forming periosteal flaps 771
844. A stump showing mode of applying suture and drainage-tube 772
845. Disarticulation of phalanx, anterior flap . . . 773
846. Guides to articulation . . 773
847. Phalanx flexed . . . 773
848. Amputation of part of a finger 774
849. Amputation of a finger . 775
850. Amputation of entire finger 775
851. Amputation of all the fingers 776
852, 853, 854. Amputation at metacarpo-phalangeal articulation . . . 776
855. Amputation of right thumb 777
856. Result of amputation of thumb 778
857. Amputation of a single metacarpal bone . . . 778
858. Amputation of all of the metacarpal bones . . 778
859. Hand after amputation of metacarpal bones and first two fingers . . . 779
860. Hand after removal of metacarpal bones and three fingers 779
861. Incision in removal of first metacarpal bone . . 779
862. Amputation of first metacarpal bone 779
863. Incision for removal of second metacarpal bone . . 780
864. Amputation of first metacarpal bone . . . 780
865. Incision for removal of fifth metacarpal bone . . 780
866. Hand after amputation of fifth metacarpal bone . 781
867, 868. Disarticulation of metacarpal bones of four fingers 782
869. Amputation at the wrist by long palmar flap . . 782
870. Amputation of the forearm by mixed method . . 783
871. Amputation of the forearm . 783
872. Amputation at the elbow-joint 784
873, 874. Anatomical points about the elbow-joint . . 784
875. Circular amputation at the elbow 784
876. Flap amputation at the elbow 784
877. Flap amputation . . 785
878. External flap . . . 785
879. Amputation of arm by flap operation . . . 786
880, 881. Disarticulation at the shoulder . . . 787
882. Esmarch's tourniquet applied to the shoulder . . 787
883. Oval method . . . 787
884. Amputation at shoulder by Spence's method . . 788
885. Amputation at shoulder-joint 789
886. Amputation of arm at shoulder 790
887. Surgical guide to foot as expressed by anatomy . 791

FIG. PAGE
888. Lines of incision . . 791
889, 890. Amputation of large and small toes . . 791
891. Amputation of the toes . 792
892, 893. Amputation through the metacarpal bones . 793
894. Incision for removal of great toe and metatarsal bone . 793
895. Amputation of the great toe 793
896. Incision for removal of little toe and metatarsal bone . 794
897. Amputation of the little toe and its metatarsal bone . 794
898. Incision for removal of two toes 795
899. Points of incision for removal of foot at tarso-metatarsal articulation . . 796
900. Disarticulating second metacarpal joint . . . 796
901. Plantar flap . . . 796
902. Formation of plantar flap . 796
903. Stump after amputation . 796
904. Outer side of foot . . 797
905. Inner side of foot . . 797
906. Chopart's amputation . 798
907. Stump after Chopart's amputation . . . 798
908. Tripier's operation of the foot 798
909. Syme's operation. Inner side of foot . . . 800
910. Line of incision for Syme's operation . . . 800
911. Syme's amputation of the foot. Anterior incision and disarticulation . . 801
912. Syme's amputation of the foot. Cleaning the os calcis 801
913. Mackenzie's method . . 801
914. Roux's method . . . 801
915. Pirogoff's amputation . 802
916. Line of incision for Pirogoff's operation . . 802
917. Pirogoff's amputation . 803
918. Stump after Pirogoff's amputation 803
919. Supra-malleolar amputation 804
920. Esmarch's method for bloodless amputation . . 805
921. Bilateral flaps . . . 805
922. Stump after bilateral flaps . 806
923, 924. Amputation of leg . 806
925. Teale's amputation . . 807
926. Amputation of right leg . 807
927. Amputation of the leg by the mixed method . . 808
928. Amputation by lateral flaps 809

FIG. PAGE
929. Amputation at the knee and lower third of thigh . 809
930. Carden's amputation with long posterior flaps . . 809
931. Amputation through the condyles 810
932. Lister's method for bloodless amputation . . . 811
933. Amputation of the lower third of thigh . . . 812
934. Amputation of the thigh . 812
935. Gritti's amputation at the knee 813
936. Arrest of hemorrhage . 813
937. Furneaux Jordan's method of amputation at the hip-joint 814
938. Amputation at the hip-joint . 815
939. Lordosis 817
940. Kyphosis 817
941. Lateral curvature of the spine 818
942. Double lateral curvature . 818
943. Quadruple curvature . . 818
944. Curvature before suspension 819
945. Curvature removed by suspension 819
946. Plaster jacket . . . 821
947. Supernumerary thumb . 822
948. Apparent fusion of the hands 822
949. Seton inserted . . . 823
950, 951. Diagram of flaps in operation for webbed finger 823
952. Operation for webbed finger 823
953 Club-foot 825
954. Club-foot shoe . . . 825
955. Club-foot apparatus . . 825
956. Talipes calcaneus . . 826
957. Shoe for calcaneus . . 826
958. Club-foot. Three grades of severity 826
959. Mode of stretching foot in talipes varus . . . 827
960. Varus treated by bandage . 827
961. Foot before operation . 828
962. Bones removed . . . 828
963. Foot after operation . . 828
964. Club-foot 828
965. Hollow claw foot . . 829
966. Apparatus for obtaining extension of the toes without division of tendons . . 829
967. Apparatus for overriding of the toes 830
968, 969. Congenital hypertrophy of toes and foot . . 830
970. Osteoclast 831
971, 972. Result of osteotomy for bowlegs . . . 833

FIG. PAGE
973. Macewen's chisel . . . 833
974. Drawing illustrating Dr. Ogston's operation . . . 834
975. Appearance of limbs before and after Macewen's operation 835
976. Extension apparatus . . . 840
977. Adams's saw . . . 842
978. Shrady's subcutaneous saw ·842
979. Section of femur forming a half tenon . . . 843
980. Wedge 843
981. Drills 845
982. Apparatus for forearm . 846
983. Apparatus for arm . . 846
984, 985. Apparatus for leg . 847
986. Knee cap 847
987. Apparatus for patella . 847
988. Apparatus for femur . . 848
989. Apparatus for fingers . 848

FIG. PAGE
990. Apparatus for carpus . 849
991. Apparatus for ankle . . 849
992. Apparatus for paralysis of leg 849
993, 994. Apparatus for paralysis of thigh . . . 850
995. Apparatus for paralysis of leg and thigh . . . 851
996. Apparatus for paralysis of both limbs . . . 851
997. Apparatus for useless elbow 852
998, 999. Apparatus for fingers 852
1000. Apparatus for hand . . 853
1001. Apparatus for hand and arm 853
1002. Apparatus for forearm and arm 854
1003. Artificial foot . . . 854
1004. Artificial leg . . . 854
1005. Artificial legs for both limbs 855

OPERATIVE SURGERY.

I.

THE PRINCIPLES.

CHAPTER I.

THE CIVIL OBLIGATIONS OF THE SURGEON.[1]

The principles of an art are those general truths and maxims which competent authority has established. If an art is progressive, like operative surgery, the principles cannot all be fixed and permanent, but must change with the advance of scientific improvements. These changes take place gradually, for alleged new truths do not obtain the weight and importance of principles until they have received the sanction of recognized authority. In order to determine, therefore, the principles of an art susceptible of constant improvement, it is necessary to consult the opinions of its acknowledged exponents at the particular period under review. An adequate knowledge of the principles of operative surgery, as thus established, is a part of the civil obligation of the surgeon, for the standard of judicial estimation of his responsibilities, in any case, is an intelligent application of those principles in practice.[2] And the same criterion is required by the professional obligation. But this measure of success implies special qualifications, for though capital operations are attended with a certain degree of risk to life, and the minor or insignificant may have a fatal issue from causes which are not always easily determined,[3] it is nevertheless true that the results of operations depend largely upon the capacity and qualifications of the surgeon.[4] Whoever undertakes to practise any art or profession assumes an obligation, both civil and professional, which, though implied, has all the force and validity of a formal contract.[5] In legal construction, this obligation requires that every practitioner of operative surgery shall (1) possess that degree of knowledge, skill, and experience which is ordinarily possessed by the professors of the same art or science; and which is regarded by those conversant with that employment as necessary and sufficient to qualify him to engage in its practice; (2) that he use reasonable and ordinary care in the exercise of his skill and the application of his knowledge to accomplish the purpose for which he was employed; (3) that he use his best judgment.[1]

---

[1] Hon. M. R. Waite, Chief-Justice, U. S.

[2] Espinasse.

[3] S. D. Gross.

[4] C. Sédillot.

[5] Justice Tyndall.

I. THE REQUISITE QUALIFICATIONS OF THE SURGEON.

The measure of qualifications which the surgeon must bring to the discharge of his duties is defined to be competent knowledge of the principles of the art and adequate skill in the application of that knowledge. But there can be no fixed limit to these qualifications, for the required knowledge and skill rise in proportion to the value and delicacy of the operation.[2] Every case necessarily has its own peculiarities, and, therefore, there can be no universal standard of treatment established.[3] Even the most trivial operation is liable to serious complications, requiring for its successful management a wide range of knowledge, a high order of skill, and the largest experience. Recent judicial decisions and legal opinions have more distinctly defined these qualifications.

The knowledge required is that reasonable degree of learning which is ordinarily possessed by others of the profession ;[4] or the requisite knowledge to enable the surgeon to treat such cases as he undertakes with reasonable success, or understandingly and safely ;[5] or, again, he must have that degree and amount of knowledge of the science which the leading authorities have pronounced as the result of their researches and experience up to the time, or within a reasonable time, before the issue or question to be determined is made.[6] It follows from these decisions that the surgeon who fully complies with the obligation must have adequate knowledge of the medical sciences—anatomy, physiology, and pathology; and of the practical branches—medicine, surgery, obstetrics, and therapeutics. He must also be familiar with the current opinions of the leading authorities, for as surgery is a progressive science his patient is entitled to the benefits of new discoveries.[7] Without such knowledge no case can be treated understandingly and safely.

The skill implied in the contract is the ordinary skill of the profession,[8] or a reasonable, fair, and competent degree of skill.[9] The lowest grade of qualification which is now regarded as admissible is the least amount of skill compatible with a scientific knowledge of the healing art.[3] But skill in operative surgery requires manual dexterity. The success of the operation may depend upon the dexterity of the surgeon alone, when he must employ the skill requisite to accomplish it ;[10] but if the operation is a part of the general treatment of the case, the degree of manual dexterity must be equal to that exercised by other surgeons at the time and in the place where the act is performed.[11]

[1] Leighton *v.* Sargeant.
[2] Bouvier.
[3] J. Ordronaux.
[4] Branner *v.* Stormont.
[5] Patten *v.* Wiggin.
[6] J. J. Elwell.
[7] McCandless *v.* McWha.
[8] Justice Story.
[9] Justice Tyndall.
[10] Ohio case.
[11] Haire *v.* Reese.

II. THE CARE REQUIRED IN EACH CASE.

The degree of care bestowed on each case must be such as surgeons of common prudence would employ.[1] There is no standard of comparison by which to determine what is ordinary or reasonable care, but each individual case must stand upon its own merits.[2] In the care of any case the surgeon must conform to established precedent, and be diligent in the application of remedial measures.

Conformity to established rules of practice has, from the earliest periods, been rigidly exacted. It is held that any deviation from the established practice shall be deemed sufficient to charge the surgeon with malpractice, in case of an injury arising to the patient.[3] This rule is designed to protect the community against reckless experiments, while it admits the adoption of new remedies and modes of treatment only when their benefits have been demonstrated, or where, from the necessity of the case, the surgeon must be left to the exercise of his own skill and experience.[4]

Diligence in the care of a case is the faithful application of knowledge and skill. The possession of the requisite qualifications, and failure to employ them sedulously for the benefit of the patient, is negligence, and negligence is as much a fraud upon the employer as want of skill, for it is upon the diligent application of skill that the problem of success must rest.[5] It is held that whenever any important step in the treatment of disease is neglected, or any important stage of it is overlooked which might have been used for the benefit of the patient, then it may be averred that the surgeon has been guilty of negligence.[5]

III. GOOD JUDGMENT IS BASED ON KNOWLEDGE.

In every case, good judgment must characterize the professional acts of the surgeon. By good judgment is understood judgment based upon a knowledge of the medical sciences.[6] There are few diseases where a single course of treatment can be adopted; in general, differences of opinion must exist as to the best course to be taken.[7] Good judgment wisely determines the course to be pursued, and applies appropriate means to secure given results. Hence it follows, good judgment and manual dexterity are essential elements in the practice of operative surgery. Though both are important, they are not equally so; good judgment in the selection and employment of remedial measures excels manual skill in effecting favorable results in cases where both are required.[8] When happily combined in the same person they give the highest measure of success. But as these qualities are susceptible of unlimited improvement by culture, the surgeon is culpable who does not attain to that degree of skill which the civil obligation exacts.

IV. THE RESPONSIBILITY IS INDIVIDUAL.

The civil obligation imposes important individual responsibilities upon the surgeon. He must exercise his best skill and judgment in every case.[1] And wherever great and extraordinary skill is possessed, causing his employment exclusively on that account, he must bestow it to the full measure of his ability, since the exceptional degree of that skill is the moving consideration to his employment.[2]

---

[1] Cater v. Fernald.
[2] Hilliard.
[3] Espinasse.
[4] Carpenter v. Blake.
[5] J. Ordronaux.
[6] Courtney v. Henderson.
[7] Leighton v. Sargeant.
[8] J. Ashhurst, Jr.

The responsibility also for the success of every operation which he performs is individual. He may decline to undertake any case,[2] but having accepted the trust, he alone is responsible for the results of treatment.[3] Neither the attending physician, nor the consulting surgeon, assumes any portion of the obligation. Throughout the entire case the conduct of the surgeon must be characterized by fidelity to the patient, and a uniform and consistent application of skill in the treatment of the disease. Failure at any time to meet the ordinary indications in the case vitiates the entire attendance, for the obligation is continuous to the termination.[4] In view of these facts, it is important that the surgeon should make every case which he undertakes peculiarly his own. He should forecast every possible source of failure, and be prepared for every possible emergency, for he is the most ready to take responsibilities and to bear them lightly who can best estimate what are the risks and difficulties which he is to incur.[5] In diagnosis, prognosis, operation, and after-treatment, his opinions should be formed, and his course of procedure marked out and followed, without being unduly influenced by the solicitation of patient or friends, or the suggestions of consultants. Every step should be taken with that painstaking care and deliberation which leave no ground for a charge of ignorance, negligence, or want of skill. Thus the surgeon not only fulfils the just requirements of the obligation, civil and professional, but secures that confidence and self-reliance, in every stage of progress, and in every emergency, so necessary when great responsibilities are assumed.

V. ANTISEPSIS IMPOSES NEW OBLIGATIONS.

The maxims of aseptic, or, in a larger sense, of antiseptic surgery, have been so generally approved and adopted by surgical authorities, that they must now be regarded as established principles of practice. They underlie and control the duties of the surgeon throughout the entire management of the case from the first examination of the patient to the conclusion of all operative procedures and their results. In this view a new and most important obligation has been imposed upon the surgeon. If, through ignorance or negligence, he fail, in any given case, to apply these principles with reasonable care and diligence, he would be justly held responsible for any unfavorable results due to conditions which antiseptic treatment would have prevented. And it is not difficult to define with considerable precision the nature of these new responsibilities. Antisepsis, intelligently and faithfully applied, prevents suppuration in wounds, and arrests that process wherever it is in progress. Wounds treated under the new system escape dangerous complications which were formerly very frequent, as septicæmia and pyæmia. The results of this improvement in the details of practice are twofold. 1. All the ordinary operations are far more safe, and hence the prognosis, in all cases requiring operative procedures, has been rendered much more favorable. The surgeon can now undertake a great variety of operations which he would formerly have hesitated, if not absolutely refused, to perform lest he should add to the existing disease the greater dangers of a suppurating wound. It follows that the surgeon who fails to give the patient the benefit of the new and improved method of treatment of wounds would be responsible, not only for complications due to suppuration, but also for neglect if he declined to resort to an operation which would have given relief if the wound had been so treated that no suppuration would have occurred. 2. The certainty with which wounds can now be protected from the dangers of suppuration has greatly enlarged the field of operative surgery.

---

[1] Paten *v.* Wiggin.
[2] J. Ordronaux; J. J. Ewell.
[3] F. C. Skey.
[4] Bellinger *v.* Craigue.
[5] Sir J. Paget.

Failures in the treatment of wounds at a surgical clinic, systematically carried on, have become as rare as accidents on a well-managed railroad.[1]

Operations are successful which but recently were, either altogether unknown, or were suggested only to be condemned. As a consequence, diseases are now amenable to treatment by operative methods which were formerly fatal, or which caused long and painful invalidism. The surgeon who fails to resort to such new operations because of their danger when performed according to old methods, to which he still adheres, or who performs them without protecting the wound from suppurative inflammation by every recognized means at his command, cannot escape the unfavorable consequences of his acts.

It will doubtless be asserted that there are eminent surgeons who discard antiseptic appliances, and who yet obtain results quite equal to those claimed by the most enthusiastic advocates of antiseptic methods. While this statement is true, the rule above given is not invalidated by the exceptional success of a few surgeons who pursue other methods. These pioneers may in time establish new procedures which will be accepted, but to-day the principles of antiseptic treatment of wounds have been approved by the recognized surgical authorities of the world, and must be the basis of judicial estimation of the civil obligation of the surgeon in his operations, until a new standard is established by equally competent authority.

It is, therefore, a matter of the utmost concern to every surgeon to become thoroughly familiar with the principles and practice of antiseptic surgery, to provide himself with the most approved appliances, and to give to every patient committed to his care the full measure of success which it can afford. And, it may be added, that those who teach operative surgery, whether orally or by writing, are under a moral obligation to explain fully the principles of antisepsis, and to illustrate all the details of its practice. No practitioner can now plead ignorance of the method of antiseptic practice, as the rules are simple and concise, nor can it be alleged that the method is impracticable in the service of a surgeon located in the country, as all the requisite materials can be readily obtained, and transported with ease, and can be applied in the most humble cottage.

---

[1] T. Billroth.

CHAPTER II.

THE PRINCIPLES OF ANTISEPTIC SURGERY.

ANTISEPSIS thoroughly applied in practice modifies every stage in the management of a case. It becomes a new and valuable aid in diagnosis by rendering necessary exploratory operations safe; it changes entirely the former prognosis by making ordinary operations harmless, and enlarging the field of operative procedures; in treatment it completely revolutionizes all previous methods. A knowledge of the principles of antiseptic surgery therefore lies at the very basis of successful practice. In order to fully understand the principles of antisepsis it is important to examine the condition of a wound, both as regards the process of healing and of suppuration.

The normal changes in a wound are stated as follows:[1] Mechanical irritation resulting from the passage of the instruments through the parts appears to throw a thin layer of the tissues at the cut surface into a condition of suspended vital activity, in which, the normal relations between the blood and the living solids being interrupted, the minute vessels become clogged with the blood corpuscles, and coagulable plasma is forced through their parietes and flows out upon the surface of the wound; the fibrin of the coagulating plasma forms the lymph which encrusts the cut surface, while its other and far larger constituent, the serum, trickling away between the lips of the wound, shows itself as the discharge which soaks the dressings during the first twenty-four hours; the original source of irritation being no longer in operation, the tissues, if free from any disturbing cause, are gradually recovering their powers by virtue of their inherent vital energy, and as they regain their functions the effusion of plasma ceases, and a process of active organization is instituted, by which the lymph is differently affected according to circumstances. If the surfaces of the wound are in juxtaposition, the lymph glues them together, and, being surrounded on all sides by healthy tissue, becomes developed in a few days into a vascular structure which constitutes a permanent bond of union between them. This is the result of a condition of rest of a wound.[2]

The abnormal changes in a wound are thus described:[1] If the surfaces are separated by serum, pent up in the interior, immediate union is prevented, and the serum, putrefying through atmospheric influence, irritates the tissues and gives rise to suppuration; or if serum be not retained but some persistent local irritation be present, such as the dragging of stitches upon an insufficient covering of soft parts, or a tightly constricting bandage, inflammation will be induced, and in proportion to its degree will interfere with the process of organic development, and convert what promised primary union into suppuration; or, if more severe, render the lips of the wound entirely inactive and incapable of producing even pus; or, if still more intense, deprive them of their vitality and cause sloughing; thus while the effusion of the lymph which is the medium of primary union depends upon a species of traumatic inflammation, the healthy organization of that lymph requires the absence of inflammation. This is the result of a condition of unrest of a wound.[1]

---

[1] J. Lister.

[2] W. W. Cheyne.

The causes of wound disturbance[1] may be mechanical or chemical. The former consist of movements of the parts, foreign bodies, tension; and they are easily avoided, usually, by the use of suitable apparatus, removal, and providing against tension. The latter are divided into two classes: 1. The substance may be an acid or an alkali which acts only according to the amount added, and the length of time that it remains in contact with the surface. 2. It may be constantly forming in the wound; this is the most formidable cause, for there is no exhaustion of the material, but continued formation of fresh matter as long as the causes are present in the wound. The latter of the chemical irritants is septic in its effects upon wounds, and induces putrefactive suppuration.

The causes of suppuration have been divided into three great groups:[2] 1. Putrefactive, due to the presence of putrid materials; 2. Antiseptic, due to the antiseptics employed; 3. Nervous disturbance, as in tension.

The latter process is the most dangerous, and formerly was the most common, complication of wounds, and it is against its occurrence that antiseptic methods are chiefly employed. In order to fully appreciate these methods it is necessary to thoroughly understand the nature of putrefactive suppuration.[3]

Putrefactive suppuration is a species of fermentation or decomposition caused by vegetable organisms, which, by virtue of their lightness, float everywhere in the atmosphere as dry dust, and often fall with other particles, cling to our clothes, hands, instruments, dressing materials, sponges, in the silk used for ligaturing and sewing; they are really omnipresent, and would destroy all other organic life were not their propagation, like that of other vegetable germs, subject to certain conditions, as moisture, rest, favorable soil. But they exert their injurious fermenting action like yeast, only as long as they germinate and multiply.

The manner of action of the variously formed organisms appearing with putrefaction included under the name coccobacteria septica,[4] is not yet plainly demonstrated. It is clear that organic substances, unstable as most of the tissues of the animal body are, become changed, that is, rearranged or rather decomposed when they are brought under entirely new conditions and that without the accession of specific agents of such change or decomposition. But it is now very generally recognized that the dangerous forms of inflammation of wounds are excited by those changes in the blood, or in the inflammatory products which are brought about by the entrance of agents of putrefaction from outside, and that surgical fever depends upon the absorption of these products; further, that surgical fever and septic fever are not different processes, but only greater or less degrees of the same process, which may be accompanied by

[1] W. W. Cheyne.

[2] J. Lister.

[3] V. R. v. Hacker.

[4] T. Billroth.

venous thrombosis and infectious emboli (multiple abscesses of pyæmia), though these are not necessarily present.[1]

Aseptic surgery[2] is based on the principle of the exclusion of active ferments from the discharges of wounds; this is the ideal form of antiseptic surgery, for if the attempt is successful the causes of putrefaction do not enter the wound in a state capable of producing fermentation, and therefore decomposition of the discharges or of dead portions of tissue cannot possibly occur. The methods of accomplishing these results have been improved by experience, and though individual surgeons have preferences for the various agents which may be successfully employed, yet the general principles governing the antiseptic treatment of wounds are now fully established.

Aseptic surgery is not treatment by spray, nor by gauze, nor by spray and gauze, nor by carbolic acid, but is any method of treatment which aims at and succeeds in excluding the causes of fermentations from wounds.[2]

They have been formulated as follows by competent authority:—[3]

Abundant disinfection of the wounds by irrigation with antiseptic fluids should be practised. These fluids prevent foul putrefaction after thorough cleansing of the parts surrounding the wounds. During an operation the germs of infection should not be brought by means of the atmosphere, fingers, instruments, or any other object which comes in contact with the wound. If any are carried to it they are rendered harmless by the irrigation, and, at the same time, blood-clots and secretions from the wound are removed. Wounds which have not been under treatment till some time after the injury, and hence may have been infected, must be persistently irrigated with the stronger antiseptic solutions in all directions and in all corners and pockets; if necessary, incisions are to be made which may afterwards be utilized for inserting drainage tubes.

Perfect hæmostasis during and after the operation must be secured thus: All bleeding vessels, even the smaller ones, are seized, and ligatured with disinfected ligatures, in order to obtain union by first intention, and to prevent subsequent hemorrhage.

Free drainage and moderate compression are obtained[1] by the use of inserted perforated rubber tubes, providing an exit for the secretions and preventing the accumulation of the same in the pockets of the wound cavity, so-called dead spaces;[4] light compression is applied to aid the carrying off of the fluids of the wound and the apposition of the surfaces by means of a bandage, which must never cord.

Union by first intention must be secured, if possible, by bringing and also maintaining the surfaces of the wound in exact contact with one another. This most rapid method of healing best protects the wound from the collection, putrefaction, and absorption of the secretions. After the removal of the blood clots, the skin should be exactly apposed by deep and superficial stitches, except where drainage tubes open.

An antiseptic dressing, containing antiseptic materials, is applied, in order to take up the secretions flowing from the drainage tubes, from the clefts or from the surfaces of the wound, as the case may be, thus preventing the decomposition of the secretions and closing the wound against putrefactive agents from without; in order that not even a small amount of blood and secretion shall reach the surface of the dressing, quite a large piece of impermeable material is placed over the first layers of the dressing, under which the secretions spread into the absorbent material and finally (but only where very abundant) reach the surface at the edges of the dressing.

[1] V. R. v. Hacker.

[2] W. W. Cheyne.

[3] V. R. v. Hacker, Billroth's Clinic.

[4] Mikulicz.

Infrequent and cautious change of dressing is necessary in order to obtain for the wound the rest which is so important for its healing and to avoid every irritation. The dressing should not be renewed without good reason, viz., to remove the stitches and tubes, or when a high temperature points to obstruction to the exit of the secretion and to the consequent process of decomposition in the wound, or when the secretion has reached the edge of the dressing, so that it comes in contact with the atmosphere; when the dressing is changed, the wound should be touched as little as possible; the cavity of the wound is not syringed out except when first intention and an aseptic course have not been attained; the tubes are tested, and, if obstruction requires, they are withdrawn and syringed out; the edges of the wound are cleansed with moist cotton-wool and then the dressing applied.

CHAPTER III.

THE EXAMINATION OF THE PATIENT.

In order to form a judgment which will guide to the proper treatment of any case involving the question of an operation, there must first be a systematic examination as to the nature of the disease, the condition of the patient, and of all the circumstances favorable or unfavorable to success. While it is true that the unfavorable issue of cases may come of things which nothing far short of omniscience could have detected beforehand, yet often the disaster can be directly traced to some oversight, carelessness, or want of judgment or of skill.[1] No operation should be performed except in urgent cases, unless the patient's history and general condition have been scrupulously inquired into;[2] even in cases demanding an immediate operation, there may still be opportunity for inquiry as to previous health and habits, and to examine the heart and lungs, and perhaps the secretions of the kidneys. In delayed operations, the surgeon would be culpably negligent who did not inquire into constitutional peculiarities, and functional and organic affections, for the timely discovery of morbid conditions of the viscera renders possible the use of appropriate remedies before the operation. The occasional fatal results of anæsthetics are sometimes due to organic diseases of the kidneys, which by proper care might be protected from the injurious effects of these agents.

I. DIAGNOSIS.

The first step in the management of the case is the determination of the nature of the disease. The course of inquiry must be judiciously and systematically made, for on it depends the course of treatment to be pursued. An error may be attended with the most serious consequences by leading to the omission of timely and important remedies, or to the use of measures which are detrimental.[3] It

[1] Sir J. Paget. [2] G. W. Callender. [3] G. H. B. McLeod.

may thus set in operation a series of pernicious influences for which the surgeon will be held rigidly responsible.[1] It is not always possible to discover the exact condition of a diseased or injured organ or tissue, and it is a fact of daily experience that surgeons of the greatest skill will differ in their diagnosis of the nature of a given disease,[2] but failure to detect the more obvious and essential changes will always be construed as culpable negligence. As it is admitted that errors in diagnosis are due in a great majority of cases to haste and inattention,[3] the surgeon should seek, by thorough and patient investigation of every case, aided by the most approved instruments and appliances, to protect himself from such a charge. The elements of a correct diagnosis are found in (1) the history of the patient; (2) the progress of the disease; and (3) the physical examination. An investigation which will discover and place in their proper relations all the important facts bearing on the nature of the disease, must develop the following specific inquiries, under the several heads above given:—

The history of the patient includes the following series of inquiries: Sex, in its tendencies to special forms of disease at different periods of life, and to nervous phenomena; age, as it affects the development of bones and organs, the integrity of tissues, and the occurrence of organic and malignant diseases; heredity, in the perpetuation of diseases and peculiarities of ancestors; previous diseases, which leave their sequelæ, as syphilis, scrofula; occupation, which develops special maladies, as necrosis of jaw from phosphorus; habits, with which certain affections are likely to be associated, as venereal diseases with prostitution, nervous derangements with masturbation; social condition, as it is related to secret or conjugal vices of the sexes.

The progress of the disease relates to the following special subjects: Date of the attack or injury, on which depends the progress of the malady; alleged changes, which may be the clue to the true cause; symptoms which, taken in their order of development, give much of the clinical history, and afford reliable data for a differential diagnosis; the present attitude, form, and condition of the part compared with the past; the operations which may have been performed and their results; the course of treatment and its most important effects, which may be the very touchstone revealing the nature of the complaint.[4]

The physical examination must be made with all necessary aids and appliances, visual, manual, and instrumental. *First:* Color determines the circulation in a part; form indicates the existence or non-existence of enlargements of regions, when deciding as to tumors, dislocations, fractures; translucency reveals the presence of serum, as in hydrocele. *Second:* Consistence must be noted in inflammatory swellings and tumors; fluctuation in collections of fluids; crepitus in fractures; crepitation in collections of air or gas beneath the skin. *Third:* The exploring needle detects the consistence and contents of swellings and tumors; the hypodermic syringe withdraws the fluids of abscesses and cavities; the trocar[1] removes pieces of muscle for examination; the microscope determines histological peculiarities; the ophthalmoscope reveals the deep structures of the eye, the laryngoscope of the laryngeal passages, the speculum of the ear, the vagina, and rectum, and the urethroscope of the urethra and urinary bladder. With antiseptic precautions exploratory operations may now be safely made for the purpose of accurate diagnosis.

---

[1] J. Ordronaux.

[2] Walshe *v.* Sayre.

[3] S. D. Gross; T. Holmes.

[4] G. H. B. McLeod.

II. PROGNOSIS.

The prognosis is an estimate of the results which will follow any operation. It must depend primarily upon the knowledge obtained in the diagnosis, and secondarily upon that larger inquiry which seeks to discover tendencies and conditions affecting the ultimate issue of diseases, and operative procedures undertaken for their cure. The chances of recovery after operations are so largely influenced by the previous state of the patient's constitution,[2] that special inquiry should be made as to former diseases and their effects, and the existing organic and functional integrity of every important organ. Due attention should also be given to mental and physical peculiarities, and to those surrounding conditions which more or less directly modify the ordinary course of the malady under observation. In considering operative procedures due weight must be given to the steady improvements in the details of the treatment of wounds, and the constant enlargement of the field of operations. The mortality of ordinary operations has been surprisingly reduced by the employment of means of preventing suppuration, while the range of operations is daily and rapidly increasing. Injuries and diseases not amenable to any known procedure a year or more ago are now promptly cured. The following facts are always worthy of consideration whatever may be the operation:—

The native bears operations better than the immigrant.

The sex which has the greatest endurance is the female.[3]

The age is not in itself a barrier to any necessary operation,[4] but with it we connect the most regular average difference in capacity to bear operations;[5] the most favorable period is between five and fifteen; the next, between fifteen and thirty; after thirty the risk to life is more than twice as great as it was at the same period after birth.[6] Young and healthy children[5] are in danger through shock, aggravated by pain, but bear very well the loss of blood, and are little liable to pyæmia after wounds. Old persons[5] are likely to have organic diseases and degeneracies, and feeble circulation, inducing congestions, due to the sinking of the blood in the lungs, liver, intestines, and other dependent parts; are liable to die of shock, or mere exhaustion, and do not bear losses of blood, lowering of temperature, or want of food; they convalesce slowly, or after partial recovery fade, waste, and die; but the thin, dry, tough, clear-voiced, and bright-eyed, with good stomach and strong wills, muscular and active, bear very well all but the largest operations.

---

[1] Duchenne.

[2] N. Chevers.

[3] W. S. Savory.

[4] S. D. Gross.

[5] Sir J. Paget.

[6] T. Holmes.

Constitutional diseases greatly modify the prognosis, and the surgeon should be thoroughly acquainted with their etiology, pathology, development, end, and medical treatment, in order to be able to determine the indications and contra-indications for the operation, and what may be the chances of recovery.[1] In general they influence operations as follows:[2] Scrofula gives a considerable mortality, but its ill effects are seen chiefly in the imperfect healing of wounds, the swollen cellular tissue, the thin and lowly organized cicatrix, or indolent ulcers and sinuses; in the large majority of chronic cases the removal of a scrofulous part is followed by improved health, but the patient remains scrofulous, and, if old, may not bear confinement well; syphilis is liable to delay reparative action, and the operation in those who have tertiary sores may be followed by renewed tertiary symptoms; rheumatism and gout predispose to structural changes of arteries and kidneys, and to organic diseases of the heart; cancer contra-indicates operations only in its later stages, when the general health is failing; anæmia is not a bad condition in which to operate, wounds heal slowly and soundly, but if erysipelas or like casualties supervene patients are less likely to recover.

Habits and temperament[2] should be duly considered; intemperance increases the dangers of operations in proportion as it is habitual; slight intemperance is much worse than occasional great excesses; avoid operating on confirmed drunkards, unless compelled by the necessity of the case; operations are hazardous on all persons who require stimulants before they eat or work; over-eating is closely allied to intemperance in increasing the dangers of operations, especially if the over-eating is of meat and other nitrogenous foods; the over-fat are a bad class, when their fatness is not hereditary, but due to over-eating, soaking, indolence, and defective excretions, their pendulous bellies indicating omental fat, and deficient portal circulation; persons in whom the vital processes are weak, but without morbid action, repair wounds feebly, and are especially liable to real diseases of the blood and tissues, and operations should be deferred, if practicable, to some period of better health, for fear of local failure, rather than of incurring any unusual risk of life; allied to this class are the cold-blooded, with cold, damp hands and feet, dusky appearance of vascular parts, feeble circulation, small pulse, slow digestion, constipation; nervous persons, who are exceedingly mobile and excitable, whether in their sensitive or motor organs, their whole cerebro-spinal system being altogether too alert and vivacious, pass through the consequences of operations with as great impunity as any other class; malarial affections do not contra-indicate operations, but in the course of convalescence ague fits, resembling those which precede pyæmia, may occur.

Deranged or diseased conditions[2] of organs variously affect the results of operations; of the digestive organs, gastric dyspepsia is followed only by flatulence, unless vomiting is a symptom when anæsthetics are liable to excite emesis, with dangerous prostration; great caution is required with those whose biliary secretions are habitually unhealthy, or who have been often jaundiced, or who have a sallow, dusky complexion, dry skin, dilated small bloodvessels of the face, sallow and bloodshot conjunctivæ, symptoms which indicate deranged functions and abdominal plethora; enlargement of the liver, whether amyloid or fatty, is often coincident with chronic diseases of the bones in children, and either tends to cause death by exhaustion, or secondary hemorrhage; of the organs of circulation, affections of the heart are not serious hindrances to recovery from operations; shock and loss of blood are attended with more than ordinary risk in persons whose hearts are feeble or embarrassed by valvular obstruction, but a rapid or irregular pulse, without organic disease of the heart, and with respiration not exceeding twenty or twenty-five, does not contra-indicate an operation; degeneracies of the arteries are only serious when general in the extremities, especially the lower, rendering primary hemorrhage difficult of control, and secondary hemorrhage more frequent and dangerous after amputation, and so interfering with nutrition that destructive suppuration is liable to occur, with slow and imperfect healing of the wound; diseased veins complicate operations only when varicose, and cut through, as in amputations, thus exciting inflammation; of the diseases of the respiratory organs, chronic bronchitis and emphysema, especially in old people, render operations extremely hazardous, owing to imperfect respiration, cough, and loss of sleep; phthisis, when progressive, adds greatly to the dangers of operations, from the consequent fever, loss of food, and pain, but, when chronic, operations are advisable, which relieve the system of painful and wasting local diseases; persons suffering from long-standing strumous affections, with the appearance only of tubercular disease, may be greatly benefited by the removal of the diseased part; menstruation and pregnancy are conditions rendering operations undesirable.

---

[1] L. Verneuil.

[2] Sir J. Paget.

Various other affections[1] modify the prognosis as follows: severe operations during the stage of shock after injuries, and during the period of acute inflammation, with high temperature, are dangerous; spreading erysipelas, cellulitis, and gangrene add so much to the dangers of severe operations, that the chances of life are best when only the ordinary treatment is followed; avoid operations in acute pyæmia, when there are rigors once or more in a few days, and profuse sweatings, with very rapid pulse and breathing, and with delirium and rapid wasting, or with dry tongue and yellowness of skin, or any considerable number of these symptoms; but an operation is justifiable in chronic pyæmia when there is wasting and sweating, with the formation of abscesses here and there, and the injured part is manifestly useless and a source of irritation or of exhaustion; croup does not contra-indicate tracheotomy, nor peritonitis herniotomy, which are operations of necessity, and are not materially affected by the general acuteness of the existing affections; of the diseases of the kidney, those associated with the constant presence of albumen in the urine predispose operated patients to erysipelas and pyæmia; pyelitis renders operations, as lithotomy, lithotrity, and even catheterism dangerous, owing to the liability to urinary fever and retention of the materials of urine in the blood; of the diseases of the nervous system, delirium tremens is an indication of a complexity of risks, and forbids all large operations, except from compulsion; dysentery and acute diarrhœa are unfavorable, especially when irritative fever, with cellular inflammation, is present; slight and transient diarrhœa is serious only when it occurs in the old or young, or exhausted; constipation is unimportant, but, when habitual, copious evacuations may prove dangerously prostrating to the feeble; insanity renders patients more or less indifferent to pain and local injuries, but they recover from chronic ailments with difficulty. External conditions unfavorable to an operation are the epidemic prevalence of erysipelas, or low forms of fever, and an atmosphere contaminated by the presence of any contagious diseases.

---

[1] Sir J. Paget.

III. THE DECISION AS TO AN OPERATION.

The decision must be based upon the preceding investigation relating to the diagnosis and prognosis. The question of an operation enters as a new and most important element in the case, and always demands the most serious consideration, for cutting operations must be regarded as injuries inflicted at the will of the surgeon, which may destroy a person enjoying comparatively good health, or fatally aggravate other but not serious affections. The question of operation may be involved in doubt and uncertainty, requiring for its proper solution a nice appreciation of pathological conditions, operative procedures, and reparative processes. Surgeons may honestly differ in their views as to whether an operation would produce a cure, or be of some benefit, although not a radical cure; or whether the benefit would justify the operation; or, finally, whether the operation could be performed at all without destruction of life.[1] An operation is not justifiable when the patient can be cured by any medical or other means. If the disease can be cured by a bloodless operation, as well as by one with cutting, choose the bloodless method, for the danger is comparatively slight when the operation does not involve the injury of tissues.[2] The object of the surgeon is twofold, viz., to save life and to promote comfort. He must never argue that life is not worth saving or prolonging.[3] Any operation is, therefore, of undoubted propriety, which is immediately necessary to save life, as tracheotomy in laryngeal obstructions; excision of poisoned wounds; or when it is less severe than other measures, as excision of small growths, instead of employing caustics; or when it is the only measure possible, as amputation of crushed limbs; or the last resort, all other suitable remedies having failed, as herniotomy in strangulated hernia. Or, if an operation promises a complete cure or long immunity from an otherwise certainly fatal malady, it is right to operate though the procedure be severe and dangerous, as in the removal of cancerous growths.[3] An operation is, also, justifiable when there is a reasonable probability that it will promote comfort[3] though it does not eradicate the disease, as in excising a fungating tumor. In whatever form the question of an operation is presented, all of the evidence for and against it should be personally considered by the surgeon with judicial impartiality. He should never be over-persuaded by patient or friends, nor unduly influenced by counsel, to operate against convictions deliberately formed; neither the consent, nor even request, of the patient can justify such an operation.

---

[1] Walsh *v.* Sayre. [2] Sir J. Paget. [3] Lond. Lancet.

The consent[1] of the patient, or of those responsible for him, to the operation should, if possible, always be obtained. If he is not capable, as when intoxicated or comatose, or if he is a child, and parents or guardian are inaccessible, operate only from clear necessity. In order that he or they may form a correct judgment, communicate the decision, and the reasons that have led to the conclusion; make every necessary explanation as to the nature of the injury or malady, its probable course and termination, and the advantages, disadvantages, and liabilities of the proposed operation; thus you will discharge every obligation, and remit to the patient, or friends, or guardian, the responsibilities of a final judgment as to the course of procedure. As far as practicable, the deliberations of the patient and his advisers should be influenced by no other considerations than those presented by the surgeon. Should the decision be favorable to an operation, the patient again returns to the surgeon's care, and a new series of obligations is incurred. The preparation for the operation, its manual performance, and the after-treatment, present questions which will tax his knowledge, skill, and care.

CHAPTER IV.

THE GENERAL PREPARATION FOR THE OPERATION.

No ingenuity of conception or brilliancy of execution of the operator can excuse the neglect to secure, by previous preparation, every possible advantage which can in any way, however trivial, minister to success; even a successful issue cannot justify the surgeon in subjecting his patient to an avoidable risk.[2] He should strive to make the prognosis less serious, and to assure the success of the operation; this result he will most certainly attain by properly preparing the patient, choosing the most favorable moment for the operation, adopting the best method of performing it, and applying the most efficient dressing.[3]

I. THE PREPARATION OF THE PATIENT.

The first care must be given to the patient. It is important that every organ, and the entire system, be so prepared for the injury about to be inflicted, that the issue will be favorable; for the timely discovery of morbid conditions of the viscera, and the use of appropriate remedies before the operation, might, in a large proportion of cases, prevent disastrous results.[1] The effects of habits of excessive bodily indulgence in food and stimulants may be amended in a comparatively short time; previous rest, important to the recovery of the part about to be operated upon, may be secured;[2] slight derangements, which are readily amenable to treatment, may at once be corrected, such as indigestion, constipation, diarrhœa; grave affections of the kidneys, liver, heart, lungs, and nervous centres may be so improved, or the system so protected, that the operation will not be serious. Even cold-blooded persons, with feeble circulation, when suitably prepared by tonics, as iron, improve their condition, and bear operations well, being singularly little liable to erysipelas, pyæmia, and other disorders of the blood.[3] The patient should be placed under the most favorable hygienic conditions; pure air, suitable exercise, wholesome food, and undisturbed sleep are important features in the final preparation; the morale must, as far as possible, be sustained by such assurances as will secure mental quietude and hopefulness as to the result of the operation;[4] do not exaggerate its nature, but speak encouragingly of it, and of its prospective success.[5] Finally, as a severe shock to the nervous system, produced by an exhaustive surgical operation and prolonged anæsthesia, may for a time so paralyze the stomach that digestion ceases, or is greatly impaired, and the food that it contains at the moment may undergo such putrefactive changes as will render it an irritant, the food taken within six hours of the operation should be quickly assimilable, and in limited quantities; milk is, in general, the best food for this purpose, especially with children, to which may be added a small amount of whiskey; a warm, well-seasoned, and well-cooked cup of broth, or a fragrant cup of hot coffee and milk, may be preferred by the adult.[6]

---

[1] F. C. Skey. [2] W. S. Savory. [3] L. Verneuil.

II. THE TIME FOR THE OPERATION.

The time appointed must be so fixed as to avoid the error of omission, delay; and of commission, haste, by a careful consideration of the nature of the disease, the condition of the patient, and the surrounding circumstances. It must be immediate when life is threatened, and the operation offers the only chance of recovery, and should be delayed when any of the conditions enumerated would render the operation dangerous to life or abortive in its results. But not unfrequently the disease, the patient, and the circumstances combine to enable the surgeon to appoint the month, the day, and the hour. The employment of anæsthetics has so diminished the fear of operations that the surgeon may exercise his discretion as to the propriety of informing the patient of the day and hour selected.[4]

The month should be selected with regard to those meteorological conditions which are known to affect the results of operations, namely, temperature, humidity, and pressure of the atmosphere.

---

[1] N. Chevers.

[2] W. S. Savory.

[3] Sir J. Paget.

[4] C. Sédillot.

[5] A. H. Stevens.

[6] F. H. Hamilton.

The mortality from shock is greatest in dry and least in damp weather; the mortality from fever and pyæmia is greatest in damp and least in dry weather; the month of least mortality from all causes after operations is October in this latitude, which has a high dew-point, medium relative humidity and range of temperature, and low barometer; then January and April; the month of greatest mortality, from all causes after operations, is December, then May and November; the least mortality from shock occurs in October; then in September, August, January, March, and April; the least morcality from fever and pyæmia occurs in February; then in April, November, January, and July.

The day should be selected with reference to the temperature and humidity of the air. It is always better to defer an operation which falls upon a rainy or inclement day to one of sunshine.[1] The barometer is the best guide, as it forecasts the weather several hours. The following facts[2] are important: The least mortality occurs with an ascending barometer; next when it is stationary; the mortality with a descending barometer is nearly three times greater than with an ascending barometer.

The time[3] is most favorable (*a*) when the barometer is steadily rising; (*b*) when the barometer is high; (*c*) when the wet-bulb thermometer shows a reading of five degrees below the dry-bulb; (*d*) when, with a high barometer and a difference of five degrees in the two thermometers, there is a mean temperature at or above 55° F. The time is unfavorable (*a*) when the barometer is steadily falling; (*b*) when the barometer is low; (*c*) when the wet-bulb thermometer approaches the dry-bulb within two or three degrees; (*d*) when, with a low barometrical measure and approach to unity of reading of the two thermometers, there is a mean temperature above 45° F., and under 55° F.

The hour best adapted for operations, on account of both light and dryness of the air, will fall between 11 o'clock A. M. and 3 o'clock P. M.

III. THE PLACE FOR THE OPERATION.

In the selection of the place reference must be had to the comfort and safety of the patient.

The office of the surgeon is frequently the most convenient place, but a risk to the patient may thereby be incurred, which it is better to avoid, namely: the liability of rendering a simple operation dangerous by the subsequent imprudent conduct of the patient, as exposure to the elements, excitement, fatigue, or excesses of appetite.[4]

The room in the private dwelling should be chosen for its accessibility, its size, and its exposure to light at the hour of the operation; the best light in a clear day for delicate operations is reflected from the northern sky. The air[5] of the room in which an operation-wound is inflicted should be as free as it can be made from all forms of putrefactive organisms; it should not immediately communicate with water-closets, and other sources of defilement, nor be occupied as a living or audience room. The best results after large operations have been obtained when the operating room has been first purified by sulphur, and both operator and assistants have bathed and had their clothes and all the materials used about the wound thoroughly disinfected.[1]

---

[1] B. W. Dudley.
[2] A. Hewson.
[3] B. W. Richardson.
[4] Sir J. Paget.
[5] S. D. Gross.

IV. THE SELECTION OF INSTRUMENTS.

In selecting instruments care must be taken that they are of approved utility and in good condition. The surgeon cannot employ rude articles, as a butcher's knife or a carpenter's saw, in amputation, unless he is placed under circumstances which prevent his obtaining suitable instruments.[2] And he is required to employ the more recently devised instruments which have been recommended by the best authorities as preferable to those formerly in use, provided they are reasonably accessible to him. They should be so constructed as to be readily made aseptic and maintained in that condition. For this purpose the handle should be, as far as practicable, smooth, and made from non-absorbent material, and the setting of the blade or shaft should have no recesses for filth. They must be kept in good order, as dull knives, broken forceps, imperfect saws, seriously complicate operations. They must, finally, be kept in a state of scrupulous cleanliness, as blood and pus may convey contagion to the person next operated, and rust and filth may fatally poison a wound. The minor apparatus, also, must be carefully selected, for an operation may be spoiled by something that was thought too trivial for care.[3] Every practitioner should know how to select and take proper care of instruments. In order to do this intelligently he must understand something of the mechanism of instruments.

The materials[4] of which the blades of general operating instruments are made are steel, silver, platinum, gold, and aluminium. German steel is used for forceps and blunt instruments, owing to its tenacity; English cast-steel for edge-tools, as it receives a high temper, a fine polish, and retains its edge. Silver, when pure, is very flexible, and is useful for catheters which require frequent change of curve; when mixed with other metals, as the silver coin, it makes firm catheters, caustic holders, and canulated work; seamless silver instruments are least liable to corrode. Platinum resists the action of acids and ordinary heat, and is useful for caustic holders, actual cauteries, and the electrodes of the galvano-cautery. Gold, owing to its ductility, is adapted for fine tubes, as eye-syringes and points of needles. Aluminium is, by extreme lightness, suited for probes, styles, and pessaries. German silver and brass plated instruments are used extensively, owing to their cheapness. The handles may be made of ebony, ivory, shell, or hard rubber. Ebony is more generally used for larger instruments, owing to its durability and neatness. Ivory is more expensive, but makes a beautiful and durable handle. Shell is more used for light instruments, as those of the common pocket-case. Hard rubber makes an excellent handle, combining neatness, lightness, and durability, and is coming more and more into use. Next to materials, the making of the instrument determines its quality; and hence the importance of selecting those manufactured by entirely reliable workmen. If the steel is overheated in the forge the knife will be brittle or rotten; in shaping it with the file the form may be destroyed;

---

[1] C. Schroeder.

[2] Young v. Fullerton.

[3] Sir J. Paget.

[4] Tiemann & Co.

in "hardening" and tempering the steel may be spoiled; in grinding and glazing the instrument may be rendered worthless. In every stage of its manufacture, therefore, the value of an instrument depends upon the personal skill of the workman. The last act of the maker is to polish and sharpen the instrument, and thus adapt it for use.

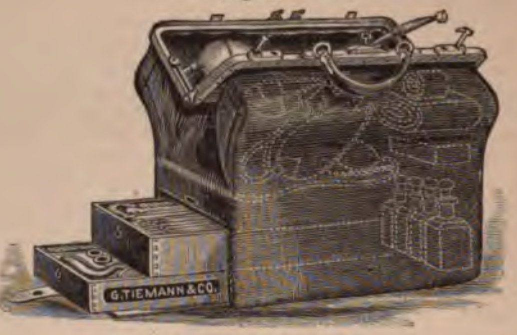
The tests of the quality of instruments are as follows: Draw a cutting instrument from heel to point slowly across the *border* of the nail, and it will catch or stop at every "nick:" draw it across the *flat* of the nail, and if at any point the edge is seen to be wiry or smooth, it is soft, and must be reapplied to the hone; but if it becomes serrated, like a fine saw, the edge is brittle, and cannot be remedied by the hone. For pointed instruments, stretch upon a test drum (a contrivance for the purpose for sale by instrument-makers) a very thin piece of kid or gold-beater's skin, and push the point through. If it enter smoothly and easily the point is good; but if a slightly crackling noise is heard it is defective. If a lancet is tested, see-saw the edge in the opening, and if it glides over without cutting, or cuts roughly, the edge is imperfect.

The preservation of instruments in good condition requires careful attention to the following details: Select a place always free from moisture and dirt for their safe keeping. Polished instruments should be suspended or placed in velvet-lined cases. After being used, every instrument should be thoroughly cleaned with warm water, and perfectly dried with chamois, or the fire, before it is returned to the case. Silver instruments tarnish when they are exposed to the air, or are brought in contact with hard or soft rubber, caustics, or acids. To preserve the edge and polish of instruments, the surgeon requires two or three small hones, some fine emery paper, two or three screw-drivers, small files, rouge crocus, or other polishing powder, chamois, and gold-beater's or kid skin. Cutting instruments should have their blades kept in perfect order by the judicious use of the hone. Occasionally the blade must be ground by a competent workman. Blunt instruments, which are designed to enter natural or other passages, should be frequently polished with fine emery paper, and then with rouge and chamois skin, in order to remove every particle of rust, and to maintain smooth unblemished surfaces. Saws are sharpened with three-cornered files, applied in the direction of the original cut of the teeth.

The case of instruments which the surgeon must provide depends upon the variety of operations which he undertakes; if limited to trifling operations, he requires only the pocket case; if he perform minor operations, he requires the minor operating case; if he assumes every grade of operation, he must add the general operating case. In selecting any case the surgeon should exercise his own judgment as to the number and kind of instruments, rather than accept the list of the maker, or of any other surgeon. The best assorted case contains many instruments which the general practitioner never has occasion to use. The following lists of different sizes will prove suggestive in the selection of a case, or in filling a case. They were designed to supply every needful instrument, together with the materials for antiseptic dressings, so arranged as to be ready for immediate use. The instruments are so constructed as to be susceptible of being maintained in a state of aseptic cleanliness.

The general operating case for antiseptic surgery is a strong leather valise, 14 inches long, 10½ inches high, and 7 inches wide. It has 2 drawers to slide out at one end; these 2 drawers have double trays, each containing all the instruments enumerated below. When these drawers are inclosed in the bag, a flap below covers up the front tight and this is locked inside by the strap passing through an aperture in the case. In the bottom of the rear part of the case is a partitioned space for 4 bottles well secured. The upper part of the valise and the drawers are entirely separated by a partition. This upper portion contains the various articles for antiseptic dressings as given in the list below:—

Fig. 1.


G.TIEMANN&CO.

General antiseptic operating bag.

Top drawer and top tray: 2 steel handle tenacula, 3 assorted scalpels, 1 blunt tenotome, 1 sharp, 1 probe, 1 hernia bistourie, 1 Levis hernia director, 1 large scalpel (extra size), 1 metacarpal knife, 4½ inch blade, 1 straight blunt-pointed scissors, 1 strabismus forceps, 1 dissecting forceps, 1 Andrews's artery forceps, 1 Hamilton's sequestrum and needle forceps with catch, 1 metacarpal saw, 1 bow saw with extra fine blade, 1 flexible bullet probe, 1 steel probe (hard rubber covered), 1 long fistula-in-ano probe (White's), 3 serrefines, 1 long and 2 short probes. Needles assorted, antiseptic ligatures on reels, plastic pins, and 2 coils of silver wire, 8 Langenbeck's hæmostatic clamp forceps.

Bottom tray: 1 long bone forceps with spring, 1 large and 1 medium chisel, 1 Stephen Smith's bone splitting (chisel) osteotome, 1 plain hollow gouge, 1 Stephen Smith's bone knife and rasp, 1 hollow gouging spoon (for bones), 1 carbonized bone gouging forceps, 1 pair double retractors, 1 trocar and canula, 1 trepanning and toe-nail extracting forceps, 1 Galt's trephine and handle, 1 brush, 1 handle with 3 bone drills, 1 antrum cutting hook, 1 burr drill, aneurism needle.

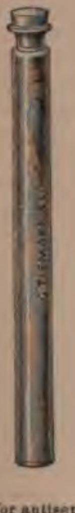
Bottom drawer, top tray: 1 Liston's amputating knife, 1 tonsil scissors, 1 T. & Co. bullet forceps, 1 thumb vulsellum forceps, 3 Wyeth's hæmostatic forceps, 1 carved alligator-jawed urethral forceps, 1 Rush's needle forceps, 1 extra large hypodermic syringe with aspiratory and exploring points.

Bottom tray: 1 uterine curette, 1 sponge holder, 1 Simpson's sound, 1 Gouley's lithotomy staff, 1 small lithotomy forceps, 2 Gouley's catheters for external urethrotomy, 1 silver double trachea tube, 1 Bozeman's vagina speculum, articulated handle and 2 blades, 4 filiform guides.

Top part of valise: 4 bottles, 1 bristle probang, 1 Knapp's ether inhaler, 1 box iodoform (Gerster's), 1 Fetch's handy aspirator, 2 aspirator points, 1 Esmarch tourniquet, 1 No. 2 siphon syringe with sprinkler (for washing), borate of cotton, antiseptic gauze, bichloride of mercury, catgut ligature, sponge, rubber drainage tubing, stomach tube for washing out stomach, 1 velvet eyed male, and 1 female catheter, etc.

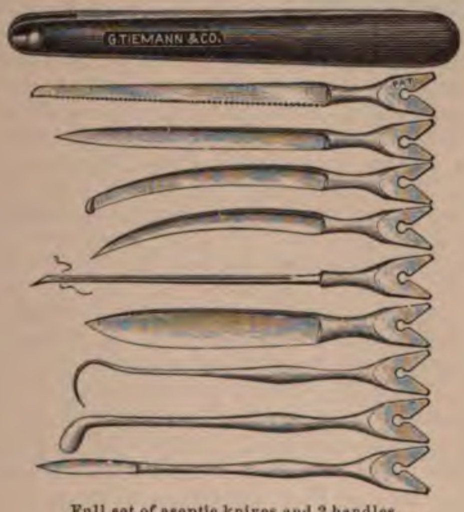
Pocket Case No. 1: Largest size case contains the following instruments, above knives, etc., viz: 1 metacarpal saw, 1 straight bistourie (finger knife), 1 probe-pointed bistourie, 1 sharp-pointed bistourie, 1 exploring needle adapted also for a perineal suture needle, 1 scalpel, 1 tenaculum, 1 gum lancet also for scarifying, 1 tenotome, 2 handles adapted for all, 1 spatula and elevator, 1 double vaccinating and 1 small bleeding lancet, 1 pair scissors straight, 1 pair silver probes, 1 (Parker's) sterling silver male and female catheter with seamless pure silver or aluminium caustic case, 1 director and aneurism needle, 1 fenestrated spring catch artery forceps combined with needle forceps on the opposite end, 1 double crossing, dressing, and hæmostatic forceps, needles, silk and wire case very compact, 2 folds with 2 inner flaps. This includes 1 bottle or vial long and slender for iodoform, 1 for bichloride of mercury, and 1 for carbolic acid.

Fig. 2.


G.TIEMANN & CO.

Bottle for antiseptics.

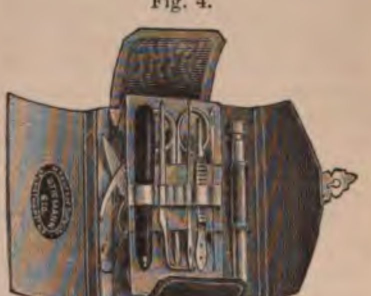
Fig. 3.



Full set of aseptic knives and 2 handles.

Directions.—To secure the blades firmly in the handle, slide the shank of the blade into the glot at the distal end of the handle, turn down the eccentric turnbolt to a right angle on either side and the blade is held firmly in position. By turning the bolt up, the blade is as easily removed. Either side of the blades fits and can be adapted so easy without even looking on. These instruments are cleaned easily and there is no danger of poisonous matters.

Fig. 4.



Compact pocket-case.

Pocket-case No. 2: 1 fold with 2 inner flaps, compact, 4¼ inches long, by 2½ wide, contains: 2 handles like No. 1 pocket-case with the following blades to fit: 1 fine tenaculum, 1 scarifying lancet, 1 delicate probe, and 1 delicate small sharp-pointed bistourie, 1 exploring and suture needle, 1 small and 1 large scalpel, 1 narrow metacarpal knife, and 1 metacarpal saw, 1 silver screw probe with Nélaton's bullet probe combined, 1 eye-screw probe, combined with silver director, 1 pair articulated scissors, 1 articulated spring catch hæmostatic forceps and 1 artery forceps with slide; needles and silk, 1 bottle or vial for iodoform.

Pocket-case No. 3 (Fig. 4) is very compact. Its length is 3¾ inches, and its width 2 inches. It contains: 2 handles like case No. 1; and the following blades to fit in: 1 scalpel, 1 probe-pointed bistourie, 1 sharp-pointed bistourie, 1 tenotome, 1 tenaculum, 1 gum lancet, 1 scissors, 1 director and aneurism needle, 2 silver probes, 1 plain artery forceps, needles and silk, 1 bottle for iodoform, 1 bottle for bichloride of mercury.

V. CONVALESCENCE.

The hygienic conditions which surround a patient, the subject of an operation, materially affect the results.[1] Foul air, filthy dressings, and indigestible food will thwart the best planned and executed operation.[2] It is, therefore, the duty of the surgeon to secure to the patient all the advantages which healthful conditions afford.[3] These are largely found in the room and its various appointments.

The room in the private dwelling best adapted for convalescence is on the second floor from the ground; the exposure should be to the south, with ample window space, and with opposite, or partially opposing, windows for thorough ventilation. The size of the room is of slight importance, except as to convenience, compared with the provisions for the outflow of foul air and the inflow of fresh air. Large cubic space does not secure purity of the air, and hence is of minor importance if the necessary amount of fresh air is supplied and properly distributed without unpleasant currents.[4] It would, however, always be wise to provide at least two hundred feet superficial area and three thousand cubic feet of air to the patient and his attendant, each, during the first weeks, to guard against defects in ventilation. As in private residences there are no other motors for changing the air than differences of temperature, and movement of the air which can be excited by heat or wind-fans, these agents must be employed to give motion to the air.[5] The common open fire-place, well heated, furnishes the best heat supply for movements of the air, while the inlet and outlet of air is maintained by raising and dropping the sashes of the windows. The walls should be freshly lime-washed, floors cleaned with carbolic solution; no sink for slops, nor wash-bowls drained into common house-drains, nor water-closet should be in or communicate with the room;[6] the furniture should be as free as possible from absorbent materials; bed and window hangings, carpets, and upholstery are objectionable, and if old are dangerous. Floors, furniture, and wood-work should be cleansed, without water, by rubbing with an absorbent material.[7] Do not place the bed near the wall, in a corner, nor in air draughts.

The ward of the hospital to which the patient is to be conveyed should be free from suppurating wounds, erysipelas, and low forms of fever; the bed should be exposed to the sunlight, with any necessary screen to the face; it should have at least one hundred feet of superficial area, and four thousand cubic feet of air; the position of the bed should be three or four feet from the wall, with complete ventilation around it; if the tick is filled with straw it must be fresh; if a hair mattress is used, it, with the bed linen, should be clean, and previously well aired and sunned.

---

[1] J. E. Erichsen. [2] S. D. Gross. [3] Sir J. Paget. [4] J. S. Billings.
[5] M. Pettenkoffer. [6] Sir J. Paget; S. D. Gross. [7] A. Smith.

The nurse should be skilled in the care of persons suffering from operations, for frequently success depends upon the skill in the management of the details of nursing after special operations. Cleanliness of the wound, the patient, the clothing, the room are of the first importance; the diet and the remedies are to be carefully attended to, and the progress of the case, as indicated by the wound, the pulse, and the temperature, is to be noted at sufficiently frequent intervals to make the record of the case complete in the absence of the surgeon.

CHAPTER V.

THE METHODS OF PREVENTION OF HEMORRHAGE.

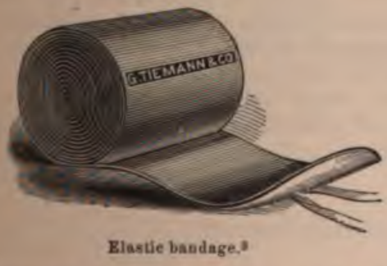
One of the most important duties of the surgeon is to deal economically with the blood of the patient committed to his charge.[1] Excessive bleeding, due to defective measures for its prevention, is culpable negligence.[2] It is important, therefore, to make suitable preparation for the prevention of hemorrhage. These measures must be adapted both to control the circulation in the limb, or part, during the operation, and to permanently close the divided vessels after the operation.

I. ELASTIC COMPRESSION.

The most perfect method of preventing loss of blood during the operation is by elastic compression so applied as to remove the blood from the part and prevent it from re-entering the vessels.

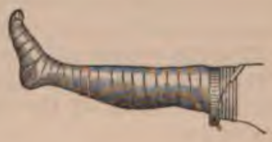
The elastic bandage[1] is the most serviceable and convenient appliance yet devised to meet all of these important indications. Select a bandage made of India-rubber (Fig. 5), and of sufficient length to extend from the foot to the hip (Fig. 6), where the last turns must be

Fig. 5.



Elastic bandage.[3]

Fig. 6.



Elastic bandage applied.

[1] F. Esmarch. [2] F. C. Skey. [3] H. A. Martin.

secured, while the remainder is removed, thus: While the patient is being brought under the anæsthetic, apply the bandage, with uniform tightness, from the extremities of the toes or fingers, according to the limb about to be operated upon, to a point above the place of operation; where the bandage ends apply India-rubber tubing, well drawn out, four or five times round the thigh, and connect one end with the other by means of a hook and brass chain, now remove the bandage first applied, commencing with the last turn, and descending to the toes or fingers, leaving the tubing in position, or fasten the bandage with a strong tape passed under the two or three last turns and tied firmly; then begin with the first turn at the extremity and remove the bandage to the point where it is fastened. The India-rubber tubing so thoroughly compresses all the soft parts, including the arteries, that not a drop of blood can enter the parts below; even in the most muscular and stoutest individuals we are able thoroughly to control the supply of blood by this simple process; the limb below the tubing resembles completely that of a corpse, and we may operate as on the dead subject; this method may be adopted in almost all operations on the extremities with more or less complete success; in extirpation of tumors, tying of arteries, scraping off of scrofulous ulcers and carious bones, and in resections of smaller bones and joints, the compressing tubing need not be relaxed until the dressing of the wound is completely finished; as in the extremities, so the supply of blood to the male genital organs can be entirely cut off by the India-rubber tubing; to remove a testicle or amputate the penis, apply a thin India-rubber tubing from behind round the root of the scrotum and penis, cross the ends in front on the mons veneris, and tie them on the loins; the tubing may perhaps be found useful in operations on the trunk, neck, and head, by shutting off the blood of all or some of the extremities, from the general circulation, by strapping, and thus forming reserve stores from which we could admit the blood successively again into the general circulation, if the patient were in danger of bleeding to death; the dangers which may arise from this method are not determined, but we must not ignore the possibility that the firm strapping of a limb for any considerable time may be followed by serious derangements of the circulation and innervation, such as thrombosis, inflammation, paralysis, etc.; when operating upon parts infiltrated with ichorous matters, it would be a wise precaution not to apply the bandage, but to raise the limb, and empty the vessels as completely as possible before applying the tubing.[1]

Elastic rings[2] of proper size, rolled upwards from the extremity of the limb effectually suppress all circulation. The advantages are complete control of the circulation, and simplicity and facility of application.

II. ARTERIAL COMPRESSION.

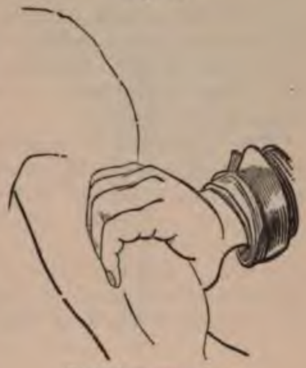
The control of the circulation may be effected by compression of the artery which supplies the part. As this method, however carefully applied, permits of the loss of the blood contained in the limb, the amount should be diminished, as far as possible, by first elevating the limb, and rubbing towards the heart.

---

[1] F. Esmarch.

[2] A. E. Spohn.

Fig. 7.



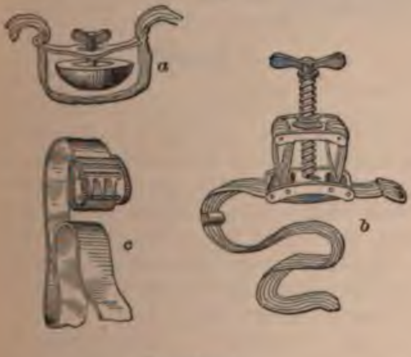
Digital compression.

The fingers afford ready and available means of arterial compression when the artery is accessible, and lies upon a bone (Fig. 7). If the thumb is used, it must be laid flat upon the vessel; in either case the pressure must not be relaxed; if the vessel slips from the grasp it should be instantly compressed again upon the bone by the fingers or thumb, but not by grasping the limb; the fingers are best employed in compression of the brachial, the radial, and the ulnar arteries; the thumb in compressing the carotid, the abdominal against the vertebræ, the external iliac against the brim of the pelvis, the femoral against the pubes, or in the upper part of the thigh.

The key, the ring being so padded as to make a hard mass, is used to compress deep-seated arteries, as the subclavian.

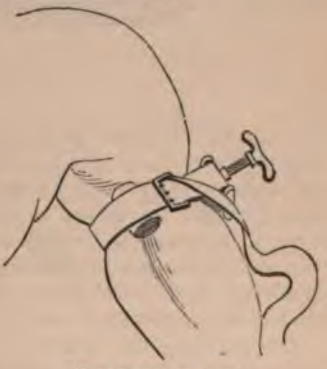
The tourniquet has several modifications (Fig. 8, *a*, *b*, *c*), but the most important difference is in the effect upon the venous circulation; they may compress the limb only at opposite points (*a*); or the entire limb, the pad being placed over the artery (*b*, *c*). The most useful instrument is that in common use (*b*).[1] In its application it is usual to put several turns of a roller around the limb at the point where it is applied, terminating with placing the cylinder of the roller over the artery as a compress; the tourniquet should now be applied, but the screw should not be placed over the cylinder, lest the ball roll

Fig. 8.



Tourniquets.

Fig. 9.



Tourniquet applied.

---

[1] J. L. Petit.

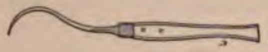
from the artery when the screw is worked. The screw being placed at one side of the limb (Fig. 9), the strap should be buckled tightly, and the screw gradually turned to the necessary tightness; if there is a liability of the slipping of the compress, put the cylinder of the roller between the pad and the strap, and apply it to the artery. The tourniquet may be specially adapted to compress the abdominal aorta,[1] or it may be devised to compress either the femoral, the aorta, or other large arteries.

The ligature is sometimes usefully applied to the main artery of the limb or part to be operated, as to the common carotid artery in operations on the face and mouth.

III. LIGATION.

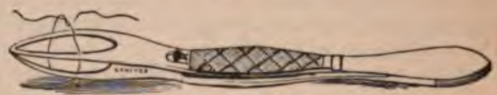
The application of the ligature to cut vessels is the favorite method of controlling bleeding during and after the operation. In applying the ligature the coats of the artery should, as far as possible, be isolated from the surrounding tissues with the tenaculum (Fig. 10), or the toothed forceps (Fig. 11). The forceps may have a slide (Fig. 12) which, drawn up while the ligature is cast around the points of the forceps, may then be forced down, and will carry the ligature directly upon the artery as the first knot is being tightened. If necessary, seize several bleeding vessels before the ligatures are applied to restrain immediate hemorrhage, and employ any form of catch forceps that may be at hand (Fig. 13). The most convenient and useful is that form employed for seizing bleeding points (Fig. 14).

Fig. 10.



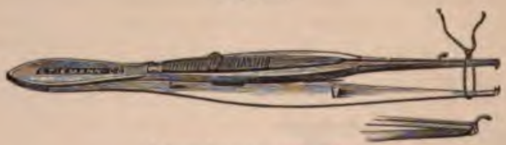
Tenaculum.

Fig. 11.



Artery forceps.

Fig. 12.



Artery forceps with slide.[2]

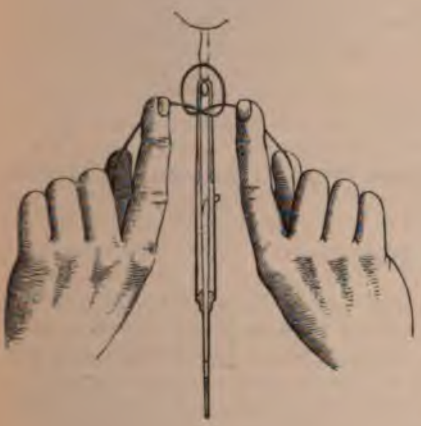
On applying the ligature, make the surgeon's knot (Fig. 16), or the sailor's knot (Fig. 17). To tie the latter knot, hold the ligature between the thumb and finger of the right hand; throw the end round the forceps, and seize the body of the ligature between the middle and ring finger of the left hand, in a prone position, the end being grasped between the thumb and index finger; draw the thread in the right hand over the end of the left index finger and the extremity of the ligature, and pass it between the ends of the index and middle fingers; now taking the end of the ligature from the grasp of the left index finger and thumb with the right index finger and thumb, the knot is completed by drawing out the portion passed between the left index and middle fingers; in tying the second knot the action of the hands must be reversed. Cut both ends near the knot, provided the ligature has been rendered completely aseptic. In some cases the bleeding vessels cannot be isolated, and it becomes necessary to

---

[1] J. E. Erichsen; J. Lister.

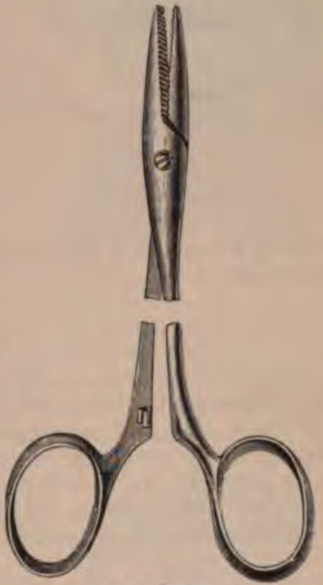
[2] H. J. Bigelow.

Fig. 13.



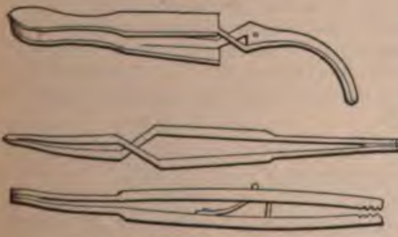
Tying an artery.

Fig. 14.



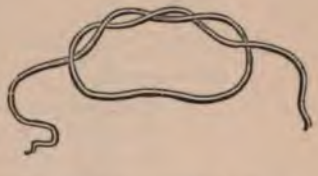
Catch forceps.

Fig. 15.



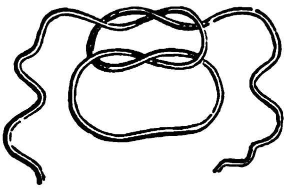
A variety of forceps.

Fig. 16.



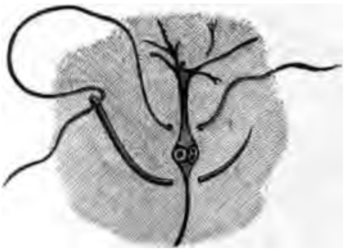
Surgeon's knot.

Fig. 17.



Sailor's knot.

Fig. 18.



Inclosing tissues.[1]

inclose a small area with a ligature (Fig. 18) passed around it with a needle.

IV. TORSION.

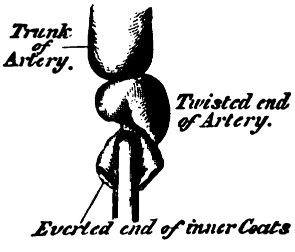
The twisting of an artery upon its axis is designed to cause laceration of the internal coats of an artery; they then roll into the calibre of the vessel and form a mesh, within which a blood clot forms and becomes organized; the external twisted coat remains as a protection and support. Torsion is a reliable method, especially when applied to small arteries, but is not generally approved for large arteries.

Free torsion is applicable to small arteries, and consists in seizing the extremity of the vessel with firmly united forceps, drawing it out from its connections, and rotating it several times.

Limited torsion is applied to large arteries, as follows:—

Seize the extremity of the artery with strong catch forceps, having blunt serrations; draw it well out of its sheath; grasp it firmly with a second forceps about one inch from the end; now rotate the first forceps three or four times, or until all resistance ceases (Fig. 19).

Fig. 19.



Tortion applied.

V. ACUPRESSURE.

Compression of the artery in the wound by means of a needle is now only adapted to cases in which the artery cannot be seized or is friable. The instruments required are bayonet-pointed pins, varying in length from three to five inches, with glass heads to facilitate their introduction, needles threaded with iron wire, and loops of slender annealed iron wire, five or six inches in length. On the cut surface of a flap the ordinary sewing needle answers perfectly well.

---

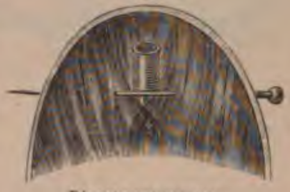
[1] F. Esmarch.

There are several methods of employing the pins to accomplish compression, but they may be reduced to three (Fig. 22, 1, 2, 3).

Acupressure is seldom resorted to, as with antiseptics it has no advantage over the ligation, except when the artery cannot otherwise be controlled.

Direct compression (Fig. 20) is made by the pin thrust through the flap, passed over the artery, and brought out of the integument of the opposite side, in such manner as to firmly compress the mouth of the artery against the muscle upon which it lies.

Fig. 20.

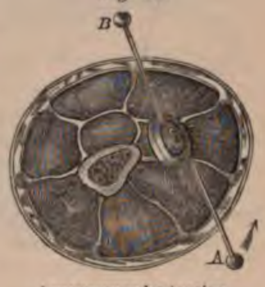


Direct acupressure.

Compression with wire is effected by passing the point of the pin under the vessel, then casting over it and in front of the artery a loop of wire which is tightly fastened to the shaft of the pin, this pin is then passed through the opposite flap.

Compression by torsion (Fig. 21) is made by transfixing the wound by a pin an inch or more, *A*, on the side of the artery, then carrying it half way around the face of the stump or wound to *B*, and thrusting it into the tissue beyond.

Fig. 21.

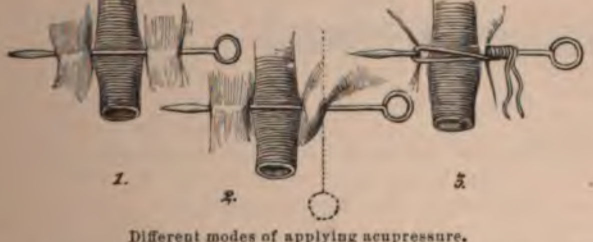


Acupressure by torsion.

The time for the removal of the pins or needles should not exceed forty-eight hours for the larger and twenty-four hours for the smaller arteries, and even a much less period has been found to suffice.

Acupressure by forceps[1] is an ingenious method of compressing vessels when there is much oozing from surfaces; the instrument consists of two blades (Fig. 23), under the command of a spring, the lower of which is a needle, and designed to transfix bleeding tissues, which done, the grasp of the hand is released, and compression is instantly effected between the blunt blade which lies upon the surface of the bleeding vessels and the needle which lies beneath them.

Fig. 22.



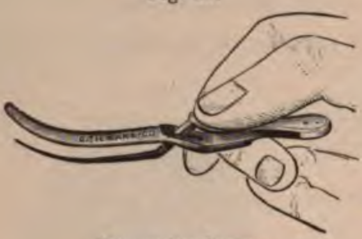
Different modes of applying acupressure.

---

[1] O. H. Allis.

Its special application is where hemorrhage takes place simultaneously from many bleeding vessels; it supplies the need of a certain and instantaneous hæmostatic in operations in which the tourniquet cannot be used, or after the tourniquet has been removed; in the latter case, though the main vessels have been ligated, the hemorrhage is often so great from numerous small bleeding points and the usual means of arrest and ligation so tardy, that fatal collapse has not infrequently resulted.

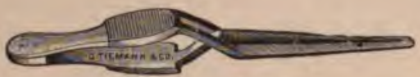
Fig. 23.



Acupressure forceps.

Beneath a bleeding area the needle is thrust, and the spring, instantly denoting that the hemorrhage has been arrested, leaves the operator to turn his attention to another point of danger. As acupressure forceps, they often render the ligature unnecessary, for no oozing will follow their removal if the vessels are small, and their application has continued for several minutes (Fig. 24).

Fig. 24.

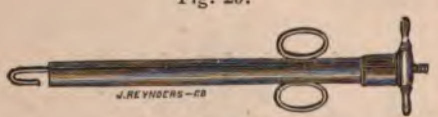


Acupressure forceps.

VI. CONSTRICTION.[1]

This method of arresting hemorrhage requires the rupture of the internal and middle coats of the artery by means of a constrictor; the ruptured coats contract, retract, and curl up; the external coat is drawn over and firmly compressed, causing invagination of the internal coats; an internal coagulum now forms, while the integrity of the external coat and the continuity of the vessels are preserved. The instrument consists of a flattened metal tube, six inches (more or less) in length, open at both ends, with a sliding steel tongue running its entire length, and having a vice arrangement at the upper extremity, by which it can be made to protrude from or retract within the tube or sheath; the lower end of the tongue is hook-shaped, so as to be adapted to the artery to be constricted; it is so shaped that having grasped an artery, it can be made to contract upon it by means of the vice at the upper end, which forces it within the sheath (Fig. 25).

Fig. 25.



Artery constrictor.

VII. CAUTERIZATION.

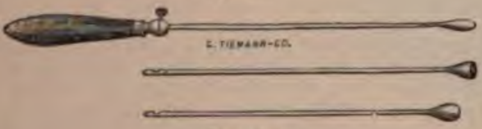
The cautery, once the only method of arresting bleeding after operations, is now required only when deep seated parts are involved, or tissues to which the ligature cannot safely be applied.

---

[1] S. F. Spier.

The actual cautery consists of an iron or steel knob, at the extremity of a long shaft, secured to a handle. The shape of the extremity may be round, or pear-shaped, or flat like a button; each form is adapted to special conditions requiring its use. It may be heated in the flame of a spirit lamp; when employed to arrest hemorrhage its temperature should be at a dull red heat.

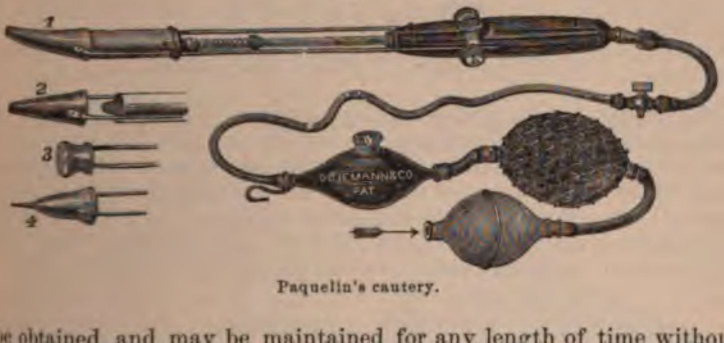
Fig. 26.



Cauteries.

The thermo-cautery[1] (Fig. 27) is a very ingenious instrument by which a high degree of heat of the cautery may almost instantly be obtained, and may be maintained for any length of time without the slightest inconvenience. It is peculiarly useful in operative procedures in the mouth, vagina, and rectum. By adapting a blade to it, dissections may be made, and with the wire écraseur, tumors may be removed in a bloodless manner.

Fig. 27.



Paquelin's cautery.

The hard rubber receiver, to which the hook is attached, is filled with wool. By removing the screw button, only a sufficient quantity of benzine or gasoline is poured in to saturate the wool; with the hook the receiver may be attached to a button-hole. By compressing the rubber bulb, the air passes into the thin rubber bag covered with netting, for the purpose of causing a continued stream of air. The air being saturated by its passage through the hard rubber receiver, is forced through the instrument into the platina point No. 1, having passed through the platina coil upon the end of the tube. The instrument may be ignited by a match, and the white or dull red heat required upon the platina points is regulated by drawing down the platina cone upon the cylinder, which, being attached to a spiral spring, yields to the pressure of the thumb. The stopcock regulates the volume of air to be passed. Various platina points, knife-shaped, flat, and needle-pointed, are easily attached.

---

[1] M. Paquelin.

VIII. REINJECTION OF BLOOD.

The collection of the blood which escapes during an operation has been collected and injected through an exposed vein with good results.[1]

The blood is caught in a dish containing a 5 per cent. solution of phosphate of soda in distilled water; the solution is further added as may be required, to keep the proportion of 1 to 3 of blood, which may be done by having the dish graduated; any error of quantity should be on the side of the soda solution. The syringe is attached to a small piece of glass tube, conveniently made pen-shaped, tied into a vein on the face of the stump; the fluid is to be injected slowly at blood-heat, the syringe being held above the horizontal, to prevent the entrance of air. The most rigid antiseptic precautions must be taken, but no antiseptic solution can be used on the wound while the blood is being caught.

CHAPTER VI.

ANÆSTHETICS AND THEIR EMPLOYMENT.

ANÆSTHESIA is the first recognized stage in all operations, and the surgeon is held strictly responsible for the selection and administration of the proper agent.[2] He may also be charged with improper conduct by female patients to whom he has administered an anæsthetic.[3] Protection from the charge of negligence is found in strict conformity with the established rules of administration,[3] and from the charge of immoral conduct by the presence of a third party.

I. GENERAL ANÆSTHESIA.

Anæsthesia[4] may be partial, full, profound, or fatal, with no distinct boundary lines between the degrees. The two intermediate degrees constitute anæsthesia proper, the first of which is desired in surgery; to produce and maintain this stage of narcosis with safety is a delicate application of means to an end; the exact relation of the thing to be done, and the power applied to do it, involves the whole question of selecting an anæsthetic, and forbids the arbitrary or exclusive use of either of the well-known agents employed. The agents which have been well tried up to the present time are nitrous oxide, ether, and chloroform; with proper discrimination in applying each of these to its appropriate uses only, and proper skill in their employment, all of the legitimate purposes of anæsthesia can be accomplished with reasonable safety.

Bichloride of mythelene and several other agents have been employed, but no one has as yet offered advantages superior, if, indeed, they have proved to be equal, to ether and chloroform.

---

[1] J. Duncan.

[2] Bogle *v.* Winslow.

[3] —— *v.* Beale.

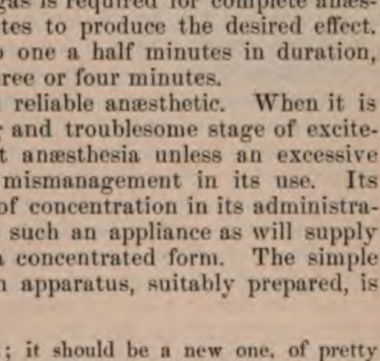
[4] E. R. Squibb.

Nitrous oxide[1] is noticeable for the certainty of its effects, the prompt recovery of patients, and its safety. It is best adapted to the momentary operations of minor surgery, because, to produce complete anæsthesia, it must be inhaled nearly or quite pure, which entirely deprives the blood in the lungs of the supply of air. An average of about seven gallons of gas is required for complete anæsthesia, and from one to two minutes to produce the desired effect. The anæsthesia is of about one to one a half minutes in duration, and passes off almost entirely in three or four minutes.

Sulphuric ether[1] is a safe and reliable anæsthetic. When it is slow in its operation, or has a long and troublesome stage of excitement, or fails to produce sufficient anæsthesia unless an excessive amount is administered, there is mismanagement in its use. Its efficiency depends upon the degree of concentration in its administration; hence the necessity of using such an appliance as will supply the ether vapor to the patient in a concentrated form. The simple cone of towels will answer, but an apparatus, suitably prepared, is preferable.

Select a stiff towel,[2] properly folded; it should be a new one, of pretty good size, taken just as it comes from the laundry; unfold no further than to display it in the dimensions of about ten inches by five; fold down two of the corners in such a way that they shall lap over each other a little, and secure them by stout pins; a cone will thus be made which fits the face admirably; the thick layers of towelling will hold sufficient ether, and its texture will prevent a too free dilution of the anæsthetic by the atmospheric air, provided the apex and seam of the cone are carefully and tightly closed, either by pins or the fingers; as the cone becomes collapsed by saturation, it should from time to time be opened, and kept in shape by distending it with the hand; unless these details are attended to, and especially the closure of the apex of the cone, the induction of anæsthesia will be uncertain and protracted; in anything so porous as a towel or sponge, the difficulty is to exclude enough air. A simple, effective, and inexpensive apparatus[3] (Fig. 28) may be made of tin. It is divided by a diaphragm of wire gauze into two nearly equal parts; the letter *a* shows the mouth-piece with the wire gauze inside, and openings for the admission of air; the cover, *b*, opens by a hinge on the side, and allows the introduction of cotton-cloth or other material, which lies on the top of the wire diaphragm, and receives the ether. There is a sliding button, *c*, which goes between the fingers, and facilitates the handling of the instrument; when not in use, this button slides in.

Fig. 28.



Inhaler.

The cone or apparatus having been properly prepared, proceed as follows:[1] First give the patient, fasting, about fifteen minutes before the time set for operation, a fluidounce or a fluidounce and a half of brandy or whiskey, if an adult male, or two fluidounces of wine if a female; this produces slight intoxication in about ten minutes, shortens the stage of excitement in many cases, and renders retching less likely to occur; the patient is then placed quietly on the table, and is advised in a low, quiet tone, to be composed and perfectly still; about ten minutes before the time for operation, the patient is required to smell the ether strongly at each inspiration, for the purpose of getting used to it; this establishes tolerance or partial anæsthesia of the mucous membrane of the air-passages, and thus avoids some of the coughing and strangling; the quantity of ether for the first charge should vary with the estimated sensibility of the patient. For an adult man, one and a half to two fluidounces, and for females and sensitive males one to one and a half fluidounces is sufficient, if the ether be good; for children, a half to one fluidounce. The most convenient place for the manipulator is at the head of the table, whence he can best apply a hand to either side of the patient's face, and thus support the cone in position without much pressure; the thumbs naturally fall into the fossæ on each side of the nose, while the fingers rest under the angles of the lower jaw ready to force the jaw forwards if respiration is embarrassed; by this act the base of the tongue is elevated and the glottis opened, care being taken not to press upon the larynx; if the patient has a beard, it should be wetted to render it less pervious to air; if, after a few inspirations of the concentrated vapor, respiration is suspended, remove the apparatus, but as soon as respiration is reëstablished, replace it over the nose and mouth; if restless excitement occurs, avoid obstruction to the mouth and nose, but under no circumstances allow the apparatus to drop off during the excited movements; if retching occur, continue the ether, but if actual vomiting is imminent, remove it momentarily and turn the patient's face downwards. The patient soon passes into the third or required stage of narcosis, often with a shudder, or slight general convulsion. Watch the pulse, respiration, and color of the surface throughout, and test the eye or the roots of the nails from time to time to ascertain the condition as to insensibility; as soon as this is fairly established, begin the operation. In a large proportion of cases not more than four of the eight minutes will have been consumed. When the operation is fairly under way, and no sensibility shown, remove the ether to avoid the fourth, or snoring stage of narcosis, and replace it when signs of sensibility are seen.

---

[1] E. R. Squibb. [2] Committee of Boston Society for Medical Improvement.
[3] R. W. Mitchell.

Chloroform[1] is the most rapid, certain, and effective anæsthetic; the facility and simplicity of its administration, the small quantity required, the certainty of good quality, its non-inflammability, its cheapness, its agreeable odor, combine to render its use popular; but, unfortunately, sudden and overwhelming paralysis of the heart, commonly called cardiac syncope, which is beyond human skill and knowledge to foresee or prevent, occasionally causes death by it. Hence, great care is necessary in the use of chloroform, when organic disease of the heart is present; but, though patients with very weak, fatty hearts are in somewhat greater danger from chloroform than other persons, yet, when cautiously given, they may take it safely, and in valvular disease the risk of chloroform would be less than that of the pain and alarm attending any considerable operation without it.[1] The administration should be by an experienced assistant. Preparatory to taking chloroform[2] the patient should be directed to omit the last meal which would naturally precede it, and to loose any tight band around the neck and waist; arrange a common towel so as to form a square cloth of six folds; pour upon it enough chloroform to moisten a surface in the middle about as large as the palm of the hand, the precise quantity used being a matter of no consequence; hold the cloth as near the face as can be comfortably borne, more chloroform being added occasionally as may be necessary; continue the administration until the eyelids cease to move when the conjunctiva is touched with the finger; meanwhile watch the breathing carefully, and if at any time it become obstructed or strongly stertorous, remove the cloth and draw the tip of the tongue firmly forwards till the tendency to obstruction has disappeared.

---

[1] E. R. Squibb.

SEMI-INTOXICATION WITH WHISKEY OR BRANDY has been found very useful in a class of cases which will not admit of an operation under anæsthetization by ether, without danger, as some crushing injuries of the limbs, fatty heart, cirrhosis of the kidneys, intolerance of ether. Many lives are sacrificed by amputations immediately on the reaction occurring after crushing of the limbs, due to the depressing effects of the ether, and slight, but sudden, losses of blood. The same is true of operations on persons who have weak hearts. The effects of ether on patients suffering from chronic diseases of the kidney, causing suppression, are disastrous in many operations. The dangers of ether in these cases may be avoided by a resort to intoxicating agents, of which whiskey is the best. In injuries attended by severe shock the wound should be thoroughly treated with antiseptics, and reaction secured by the usual remedies; then, if an operation as amputation is necessary, the patient should be gradually brought under the influence of brandy or whiskey, administered in milk or beef-juice. An ounce to two ounces of the stimulant every hour will produce a condition of semi-intoxication in six to eight hours, according to the habits of the person; the pulse will be full and slow, the skin warm, the eyes suffused, and the patient quite indifferent to the operation, and perhaps happy in expectation of it. An hour before the operation half a drachm of laudanum may be given with the stimulant, which will add to its narcotic effect. The operation may now be performed. Ether should be given by the usual method, but very little will be required to render the patient insensible; the pulse seldom varies in frequency or volume, even if there is a loss of blood; and convalescence is usually rapid. Women with fatty hearts will pass safely through such operations as removal of the breast; persons enfeebled by suppurative diseases as caries of the joints will readily endure excision; those suffering from diseases of the kidney are not endangered by suppression of urine after the operation; and those intolerant of ether are not injured by the small amount which they require.

---

[1] Sir J. Paget.

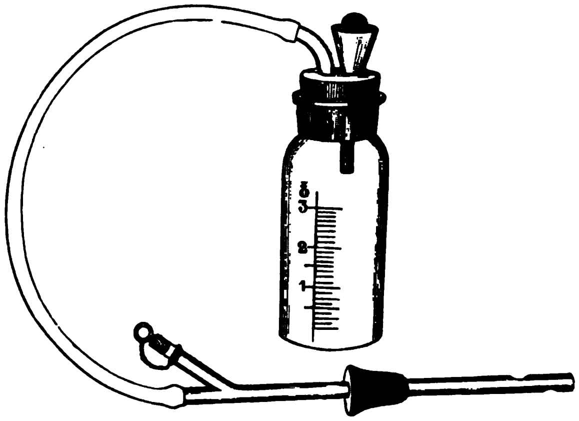
[2] J. Lister.

Etherization by the rectum[1] has been practised, but is liable to cause irritation of the bowel and other unpleasant symptoms.

Diarrhœa occurred in 7 out of 37 cases, but is believed to be due generally to preëxisting intestinal lesions, or to too great distension of the bowel.[2]

It may occasionally be usefully resorted to in operations in or about the mouth, on the palate, or nose—cases in which the inhaling apparatus would interfere with the operation. The best apparatus (Fig. 29) has a recurrent catheter, by which the gas may be allowed to escape if there is danger of over-distension.

Fig. 29.



Apparatus for etherization by rectum.

It consists simply of a water-bath, a graduated bottle provided with a funnel and valve for pouring in the ether, and a supply-pipe for conducting the vapor to the rectum. This tube terminates in a straight recurrent catheter, the exhaust-channel of which is controlled by a valve. The catheter is furthermore provided with a movable collar for pressure against the anus—it having been found that the vapor tends to escape by the side of the tube.

Rapid respiration[3] will induce a sufficient degree of anæsthesia to admit of slight operations without pain, as the passage of a probe into wounds, or manipulation of injured limbs and inflamed parts. The patient must be required to breathe rapidly for about three minutes, when there will be tingling of the surface, especially of the fingers, a feeling as if the surface were swelling, dizziness or confusion in the head, without obliteration of consciousness.[4]

II. LOCAL ANÆSTHESIA.

In trivial operations involving slight incisions, as opening abscesses, local anæsthesia is preferred. It consists in benumbing the surface with cold, or an anæsthetic.

[1] Molliere.

[2] Miller.

[3] W. G. A. Bonwill.

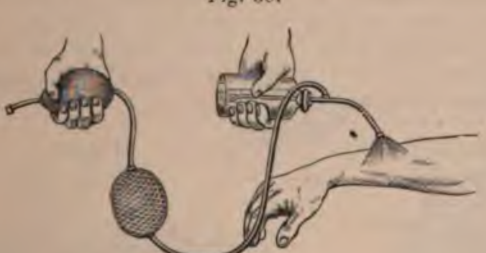
[4] A. Hewson.

Ice[1] is applied as follows: pulverize finely and mix with half its bulk of salt; apply the mass in a gauze net or an India-rubber bag; continue its application only until the surface is pale, bloodless, and insensible; if continued too long, a frost bite or chilblain will follow.

Ether in the form of spray is a very efficient and simple method of relieving a part of sensibility. For this purpose a spray-producing apparatus is required. The action is more rapid when a slight prick of a needle is made at the moment when the skin assumes a purplish hue.[2]

The most efficient anæsthetic refrigerator[3] has a continuous jet and consists of a bottle for ether and a bellows with a reservoir; put the ether in the bottle, nearly filling it, then insert the tube with the cork firmly, and fit the nozzle to give the jet desired. Grasp the bulb on the extremity of the rubber tubing and use it as a hand bellows, the other bulb acting as a reservoir; the small wires, stylets, are used to graduate the spray, which is made finer or heavier by the use of different sizes; remove the nozzle and insert the stylet in the small tube. A very efficient refrigerator, with continuous jet, may have the bottle as the reservoir (Fig. 30).

Fig. 30.



Hand spray.

Liquefied carbolic acid,[4] retained in contact with the skin for two or three minutes, causes a white spot, which is soon surrounded by a congested circle; serum is next effused, which raises the skin in a wheal; the smarting or pain now subsides and anæsthesia begins in the white part, while the congested part becomes hyperæsthetic; the anæsthesia is at its height in fifteen or twenty minutes, and involves the skin down to the cellular tissue; the affected tissues may be punctured, cut, or burned without sensation; soaking the parts with dilute acetic acid increases the effect of the carbolic acid; wounds made in tissues thus treated heal rapidly.

Hydrochlorate of cocaine[5] is an excellent nerve anæsthetic when applied to mucous membranes, and has a large range of usefulness when employed in operations on the eye, nose, ear, pharynx, larynx, urethra and anus. It is generally used as a 4 per cent. solution, but if necessary the strength may be increased to 20 per cent. Apply it with a camel's-hair pencil, or with a small swab of cotton; its effects are sufficiently marked in fifteen minutes to admit of the operation. It gives rise to very decided constitutional effects when it enters the general circulation in considerable quantities, as by hypodermic injection.

---

[1] J. Arnott.

[2] Letamendi.

[3] B. W. Richardson.

[4] J. H. Bill.

[5] Koller.

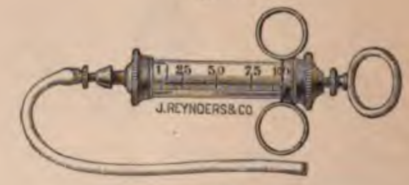
Prolonged local anæsthetization by incarceration of the anæsthetic fluid in the field of operation[1] enables the surgeon to perform capital operations with cocaine. This is best performed by the aid of the elastic bandage (Fig. 31); beginning with the toes or fingers, as the case may be, the bandage is wound around the limb in the form of a spiral, each fold overlapping the one which preceded it, the bandage being held continuously on the stretch while the manipulation is in progress, so as to deprive the extremity of blood; the bandage should stop slightly below the point where the operation is to be performed and there be secured; the injections are now made a short distance above the margin of the bandage, the first being a one or two per cent. solution, in doses of two to five minims, just below the epidermis, and as rapidly as possible; the skin being anæsthetized the second injections are made with long, fine needles attached to a syringe of a capacity of 100 minims (Fig. 32), the solutions being from one to two per cent.

Fig. 31.

J. REYNDERS & CO.

Elastic bandage.

Fig. 32.



Hypodermic syringe.

If, as the needle descends into the tissue, the solution be injected before the point at the rate of a drop or two at a time no pain will be caused; the greater the extent of the operation the weaker should be the solution to avoid constitutional symptoms.

As soon as the injections are completed, which should not occupy more than four or five minutes at the furthest, a tourniquet should be applied a short distance above the upper border of the anæsthetic zone, and if the depth and lateral expansion of the anæsthetic zone be sufficient on testing it to justify the anticipation that the operation may be conducted without pain, the bandage should be removed, and the tourniquet retained to prevent the escape of the anæsthetic into the general circulation. By this method amputations have been performed successfully without pain.

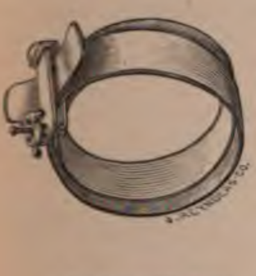
The best form of tourniquet for this purpose is an India-rubber band two inches broad and three feet long, the edges being rounded (Fig. 33); this is passed around the limb two or three times and fastened by a clamp (Fig. 34), consisting of two wings joined by a stout hinge and fastened by a powerful screw (Fig. 35).

The anæsthetic may also be limited in its action by means of rings which interrupt the circulation in the superficial veins, in places

---

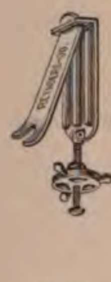
[1] J. L. Corning.

Fig. 33.



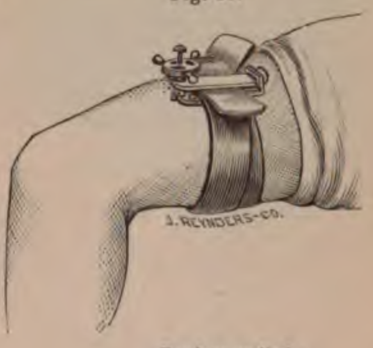
Bandage with clamp.

Fig. 34.



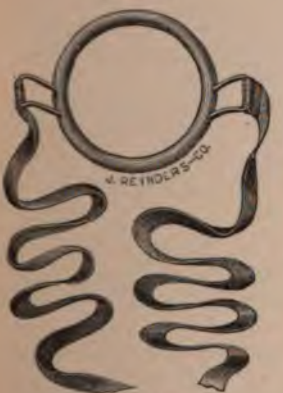
Clamp.

Fig. 35.


J. REYNDERS-CO.

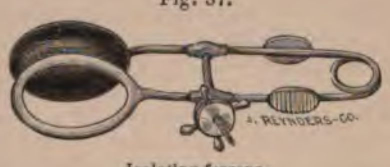
Bandage on limb.

Fig. 36.



Isolating ring.

Fig. 37.



Isolating forceps.

where the tourniquet cannot be applied, as the head, face, breast. The rings consist of thick wire, covered with India-rubber tubing passed over the wire (Fig. 36), and pressed down by strong bands. For the lips and cheeks a light forceps may be used (Fig. 37), having a metal disk on one and a ring on the other end, the disk is passed into the mouth and pressed against the cheek, while the ring is firmly applied externally by a screw; all the space inclosed is available for an operation.

CHAPTER VII.

GENERAL RULES AS TO THE MANUAL OF THE OPERATION.

The manual part of the operation may be one step in the treatment of a disease, or it may comprise the entire responsibility of the surgeon, as in cases where he is required only to operate. The result may depend upon other conditions than the operation, or upon the operation alone; in either case he is required to bring to the discharge of his duties the skill requisite to properly accomplish the object.[1] The plan of the operation should, when practicable, be carefully matured, and, if it is difficult or complex, be practised on the subject frequently before the time fixed.[2] Regard must be had for established methods in similar conditions, for the surgeon will be responsible for any unfavorable results following a departure from the ordinary and approved rules.

I. THE INSTRUMENTS REQUIRED.

All operations require the knife, the forceps, and the director; for special operations, special instruments are necessary.

The knife may be in the form of a scalpel or bistoury; the scalpel is of several sizes, and the blade varies in breadth, the broad blade being adapted to large and deep incisions, the narrow to more delicate dissections; the bistoury varies much in the shape of the blade, being curved or straight, sharp or probe pointed, broad or narrow, and with full and partial cutting edge.

The forceps should have serrated claws and a spring so firm that the extremities hold firmly under strong pressure; the common dissecting forceps loose their hold when the limbs are pressed together, and thus render dissection tedious and embarrassing.

The director, being used to raise thin tissues, as fascia, for incision, should have a deep groove terminating in a slignt cul-de-sac to prevent the escape of the point of the knife.

II. DISSECTION.

The process of exposing deep-seated parts is the dissection. The practised operator,[3] familiar with the use of his knife, and confident in himself, divides boldly and freely; his progress is clearer at every incision, his work is systematic, he proceeds slowly and steadily, every cut tells, and every movement has a meaning and an object; but timidity marks the ignorant man at every step, and uncertainty and indecision characterize his movements; he passes from one part of the wound to another without any rational object or intention, dissecting a little here and dividing a little there, but completing nothing; finding his own resources fail, he lends an ear to the suggestion of one and another, and adopting imperfectly the advice of each, protracts the operation three or four times the necessary period.

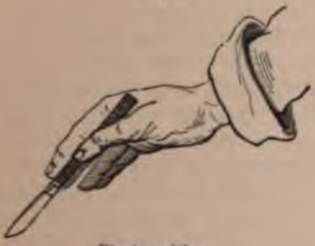
The hand[4] best adapted to make the dissection is the right; it will be of advantage to dissect occasionally with the left, but there are few who will attain the same command over it as over the right hand; besides the left always has important duties to perform and may be said to be the servant of the right.

The position[4] in which the knife is held varies with the kind of incision to be made; the most general position is nearly identical with that of a pencil or pen when held in the act of writing (Fig. 38), the thumb being applied on one surface of the handle, the index finger on the back, and the middle placed partially behind to regulate somewhat the force employed by the index, and the little finger resting on the body; this position is adapted to cutaneous incisions requiring caution in the degree of pressure, as in an operation for hernia, aneurism. For great delicacy and convenience of manipulation the knife is held like the violin bow (Fig. 39), the thumb antagonizing all the fingers. This position enables the operator to make a transverse incision. By turning the knife, held in either of these positions, upon its axis, other positions are assumed, the first adapted to opening abscesses, and the second to slitting tissues. The bistoury, straight and pointed, may be held in either of these positions, but it is more frequently held as a pen (Fig. 40), in the opening of abscesses, and in the second position in dividing fascia or parts concealed from view, when for safety its point is carried along a grooved director (Fig. 41).

---

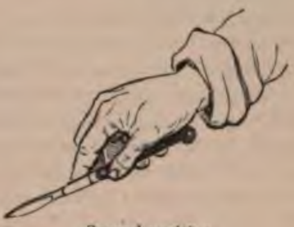
[1] J. Ordronaux.
[2] V. Mott.
[3] F. C. Skey.
[4] Sir W. Fergusson; R. Liston; V. Mott; F. C. Skey.

Fig. 38.



First position.

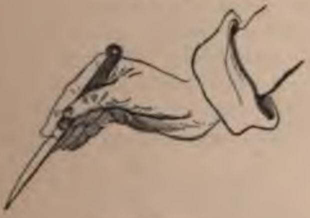
Fig. 39.



Second position.

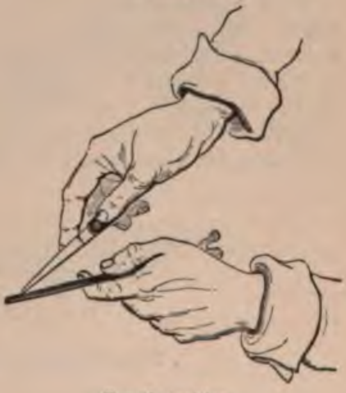
The manipulation of the knife in dividing parts, whatever may be the fineness of its edge, must be on the principle of the saw; art in the use of the knife consists in adapting the requisite force to the surface to be divided, and the less the pressure of the hand, provided the edge be applied like a saw, nearly parallel to the surface to be divided, the more perfect will be the wound, and when brought into contact, the more readily will it reunite. In dissections requiring cautious cutting, the knife should be drawn lightly and steadily along the surface with such force that the divided textures fall gently to each side, the pressure being regulated by the nature of the textures

Fig. 40.



Third position.

Fig. 41.



Fourth position.

to be cut, the proximity of important parts, and the depth of the wound. The bistoury is either carried completely through the soft parts, dividing the fascia or sinus from its remote extremity backwards towards its orifice, or, if probe-pointed, by raising the blade out of the groove, dividing from the orifice to the remote end.

The incision[1] may take any form adapted to the special operation in hand, being single or compound, straight or curved, from without inwards, or the reverse, but all incisions should, as far as possible, be made in the line of natural folds of the skin, and in the course of vessels, nerves, muscles, and tendons; when two are made in close proximity, the lower should be made first, to avoid the blood. The precise line over which the first incision is to be made must first be determined, and its length should be adapted to all the purposes of the operation, being neither of unnecessary length nor so contracted as to require subsequent enlargement. In making the first cut, render the skin tense over the part without displacing its relations, then thrust the point of the knife into the integument at a right angle with the surface, depress the wrist, and incline the edge upon the skin, make the cut of the requisite length, and elevate the wrist, placing the knife at nearly the same angle as when it was introduced; if the integument is very lax, this incision may be made by pinching up the skin, thrusting the knife through both layers, and cutting outwards. In continuing the dissection, make every movement of the knife advance the operation in an orderly manner. Each incision should so far correspond in extent with the first that the deep tissues are fully exposed; when the handle will separate tissues in the vicinity of vessels, nerves, or cavities, use it in preference to the blade; raise fascia immediately overlying important structures on the director, and then incise, unless perfectly competent to cut them directly without risk. Remove all oozing blood during the operation by absorption from time to time with an aseptic sponge.[2]

The conclusion[3] of the operation must be perfected in every detail with as much care as the first stages; there is great danger to the patient when the operator, after he has passed through the sort of mental tension in which he performs the most difficult part of what he has to do, and his attention has been completely occupied in some difficult task to be achieved, allows his mind to relax and his attention to be less keen and ready for exercise.

CHAPTER VIII.

THE EMERGENCIES LIABLE TO OCCUR.

During every stage of an operation there is a liability to sudden and dangerous accidents and complications which demand prompt recognition and energetic treatment. Some of these emergencies result more or less directly from the use of anæsthetics, while others are incident to the operation. A safeguard against the first is the selection of an assistant to administer the anæsthetic who is not liable to have his attention distracted by the operation, is familiar with all the phases of anæsthesia, and is competent to meet every indication of care and treatment.

---

[1] F. C. Skey; Sir W. Fergusson; V. Mott.

[2] J. Lister.

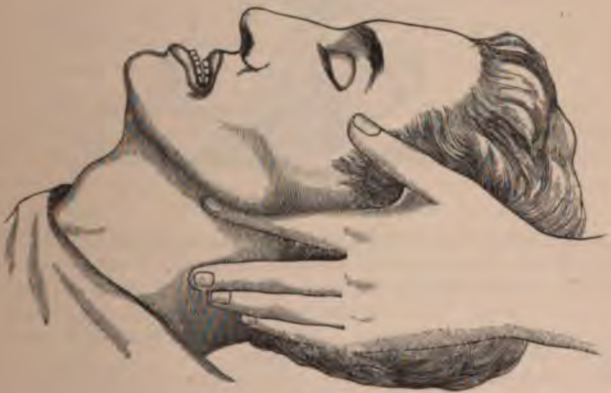
[3] Sir J. Paget.

I. NARCOSIS.

Narcosis by anæsthetics is progressive, and may advance symmetrically or asymmetrically; that is, all the vital functions may be equally and uniformly depressed to obliteration, or the narcotic influence may, in any part of its progress, be concentrated upon some one vital function, or organ, and prove fatal.[1] The most important symptom to watch is the respiration, for if obstructed breathing continue long it leads to fatal paralysis of the nervous centres.[2] Death may also commence at the heart, and hence the pulse must also be frequently examined.[3]

Profound narcosis is announced by stertor, impeded respiration, pallor, or lividity of face; such symptoms demand immediate treatment. Two methods of resuscitation are strongly recommended, both of which can always be instantly applied. The first[2] is based on the theory that respiration ceases from laryngeal paralysis, which is indicated by stertor, and may be relieved by very forcible withdrawal of the tongue; artery forceps, or a tenaculum, are the best instruments; in order that it may be effectual, firm traction is essential; the end of the organ may be withdrawn considerably beyond the lips without any good effect, but if an additional pull be given, the nervous system is aroused and respiration reëstablished. The

Fig. 42.



Pushing the jaw forward.[4]

---

[1] E. R. Squibb.

[2] J. Lister.

[3] T. Holmes.

[4] F. Esmarch.

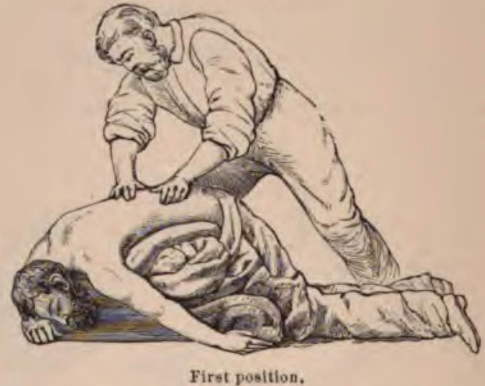
same effect is produced by pushing the angles of the jaw forward with the fingers placed behind them (Fig. 42). It is well for the person giving the anæsthetic to let his fingers rest under the jaw on either side that he may at once push the jaw forward when symptoms require it. The second method[1] consists in inversion of the body, with a view to overcome supposed cerebral anæmia, as follows: suspend the body with the head downward by elevating the thighs or hips, or by allowing the body to hang from the side of the table; separate the jaws, and draw the tongue forcibly forward; agitate the body, and practise artificial respiration; persevere in maintaining the patient in this position for thirty minutes or more, if necessary.

Apnœa from regurgitation of the contents of the stomach into the lungs occasionally occurs,[2] and requires prompt treatment by the direct method[3] of treating persons suffering from drowning.

To relieve the lungs of the fluids, proceed as follows:—

Face downwards (Fig. 43); a hard roll of clothing beneath the epigastrium, making that the highest point, the mouth the lowest; forehead resting upon forearm or wrist, keeping mouth from the ground; place the left hand well spread upon base of thorax to left of spine, the right hand upon the spine a little below the left, and over lower part of stomach; throw upon them with a forward motion all the weight and force the age and sex of patient will justify, ending this pressure of two or three seconds with a sharp push, which helps to jerk you back to the upright position. Repeat this two or three times, according to period of submersion and other indications.

Fig. 43.



First position.

Artificial respiration is produced as follows, whenever it is required: Face upwards (Fig. 44); the hard roll of clothing beneath thorax, with shoulders slightly declining over it; head and neck bent back to the utmost. Hands on top of head (one twist or handkerchief around the crossed wrists will keep them there); rip or strip clothing from waist and neck; kneel astride patient's hips; place your hands upon his chest, so that the ball of each thumb and little finger rests upon the inner margin of the free border of the costal cartilages, the tip of each thumb near or upon the xiphoid cartilage, the fingers fitting into the corresponding intercostal spaces; fix your elbows firmly, making them one with your sides and hips; then—

---

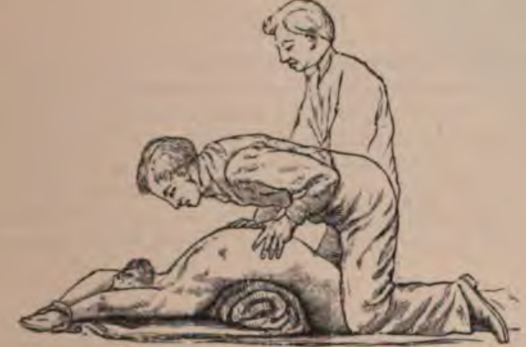
[1] Nélaton; Schuppart.

[2] Bellevue Hospital Records.

[3] B. Howard.

Pressing upwards and inwards toward the diaphragm, use your knees as a pivot, and throw your weight slowly forwards two or three seconds until your face almost touches that of the patient, ending with a sharp push which helps to jerk you back to your erect kneeling position. Rest three seconds; then repeat this bellows-blowing movement as before, continuing it at the rate of seven to ten times a minute; taking the utmost care, on the occurrence of a natural gasp, gently to aid and deepen it into a longer breath, until respiration becomes natural. When practicable, have the tongue held firmly out of one corner of the mouth with thumb and finger armed with dry cotton rag. Avoid impatient vertical pushes; the force must be upward and inward, increased gradually from zero to the maximum as the age, sex, etc., may indicate. Abandon no case as hopeless within an hour's useless effort.

Fig. 44.



Second position.

The following methods may be employed: 1, lay the patient on his back, with the shoulders elevated, draw the tongue forcibly forwards, grasp the arms at the elbow and carry them upwards firmly until they nearly meet above his head, then lower them to the side, and make firm compression upon the lower part of the sternum; repeat this process twelve to fourteen times in the minute.[1] Or 2, turn the body gently and completely on the side and a little beyond, and then on the face, alternately; repeating these measures deliberately, efficiently, and perseveringly, fifteen times in a minute.[2]

Meantime other measures should not be neglected, as external stimulants, the application of the poles of the battery to the vicinity of the diaphragm in front and the cervical region behind.

Asphyxia from blood in the trachea is an accident liable in operations involving the mouth, larynx, trachea, and vicinity; the symptoms are lividness, coldness of the surface and extremities, and, in extreme collapse, cessation of the pulse. The treatment is promptly to lower the head and raise the feet; pass a catheter down the trachea beyond the point of obstruction, either by introducing it through the mouth, or by laying open the trachea itself, and passing the catheter through the aperture; blow air through the instrument into the lungs and inflate them, in order that the air in passing out may carry the clot upward and expel it. If this pressure is not sufficient it may be aided by compressing the chest and applying galvanism to the cardiac region.[1]

---

[1] Sylvester.

[2] M. Hall.

II. BLEEDING.

It not unfrequently happens that profuse bleeding occurs from many vessels, to which the operator cannot apply the ligature without losing valuable time. This complication must be promptly met by compression of the cut vessels by the fingers of an assistant, aided by dry sponges or a towel, to which ice may be added; a skilful assistant may thus cover the exposed vessels of a large surface as the dissection proceeds. If the bleeding threatens life, reinject all the blood that can be secured, in a clean vessel, into any open vein in the wound.

III. SHOCK.

Severe reflex disturbance or paralysis of nerve centres is liable to supervene towards the close of an operation, especially on a sudden loss of blood, when the operator is least prepared to encounter so formidable a complication. In general, it is remarkable how little impression is produced by even the most severe operations,[2] and hence the surprise which the discovery of the presence of shock creates. The patient often passes suddenly from a state of proper anæsthesia, and, without any additional anæsthetic, to a condition of more or less profound shock. There is no warning of its approach, and the first impression is that too much of the anæsthetic has been given.[3] This is not narcosis from anæsthesia, but shock. The degree of prostration depends somewhat upon the previous condition of the patient and the nature of the disease, but more markedly upon the degrees of shock from the injury which gave rise to the operation, the amount of blood lost, and the length of the operation. The bodily temperature and pulse are the best guides to determine the severity and danger of shock, and ought to be noted, first, before the operation, and, second, during and after the operation; variations not accounted for by obvious causes will indicate the effect of the operation, and often give timely warning of impending danger. In an average of cases of operations, recoveries have a fall of temperature of less than one degree, and deaths of more than three degrees; a fall below 97° F. is very critical, but recoveries exceptionably occur.[4]

Syncope may be regarded and treated as an early stage of collapse. These conditions differ only in degree and duration.[5] In the former the crisis is more rapid, and in the latter the effects are more extensive and profound.[6] The symptoms are pallor, sighing, respiration, feeble pulse, and other symptoms of great prostration. The indications of treatment are to arouse the nervous system by stimulation. Place the head low; apply vapor of ammonia cautiously to the nostrils; give brandy by the mouth or rectum; apply external heat to the whole body; over the region of the heart and stomach apply cloths wrung out of hot water.

---

[1] H. J. Bigelow.
[2] G. W. Callender.
[3] J. Croft.
[4] F. Jourdan.
[5] B. Travers.
[6] W. S. Savory.

Collapse may rapidly succeed, with cold, clammy moisture of skin, and often distinct drops of sweat upon the brow, shrunken and contracted features, reduced bodily temperature, almost imperceptible and often irregular pulse, short and feeble or panting respiration. To the treatment of shock add hypodermic injections of brandy, ʒss to ʒj, repeated every five minutes, in the arms; or ether, 10 to 30 minims, every ten minutes; or weak liquor ammoniæ, 5 to 10 minims, may be injected into the veins Electricity, applied to the region of the heart, should be used. As the most unfavorable cases will frequently recover if energetically treated, the efforts at restoration should not be relaxed until recovery is secure, or death has occurred. If reaction begin, stimulation should in part give place to nutrition; the patient must remain in the horizontal position; beef-juice, with brandy, should be given at first, and milk should soon be added; subcutaneous injections of morphia are very important in securing rest and quiet; or, if it cannot be taken, hyoscyamus may be combined or substituted. Finally, tincture of digitalis may be required, if reaction is delayed, in ʒss doses every hour. External heat is always to be applied to the whole body, and cloths, wrung out of hot water, over the stomach and heart; friction of the limbs may be usefully added.

Anæmia may occur from the loss of blood, and be the cause of collapse. To the former treatment must now be added, position of the body to secure the flow of blood to the head and heart, as partial inversion; add to this bandaging of the limbs from their extremities towards the trunk. If the anæmia is extreme, transfusion should be promptly resorted to, or the re-injection of the blood lost.

IV. AIR IN THE VEINS.

A wound of a vein is liable to admit air to the circulation, causing air-embolism; it occurs during dissection in the vicinity of large veins, as in the neck or axilla; the vein having been wounded, slight traction of parts during inspiration allows the air to enter the current of blood. Air may also enter a wound of longitudinal sinus, if the head is elevated. Sooner or later it arrives at the right side of the heart, passes the valves, enters the ventricle, and remains there, dilating by its elasticity the ventricular walls; this distension may take place slowly, but it is constant, often doubling or tripling the normal size of the right heart; from this distension it results that (1) the contractile force remaining the same, and the resistance augmenting, the auriculo-ventricular contraction becomes more and more incomplete; (2) the walls contracting on a gas, instead of a liquid, compress it without driving it out; (3) the orifices of the right side remaining patulous, the foaming mixture of blood and air regurgitates into the veins, and is carried to the most distant parts of the system; this reverse current persists until the distension passes certain limits, when death results.[1] The symptoms are a peculiar sound at the bottom of the wound, like gurgling, hissing, or bubbling; a slight issue of venous blood, and often bubbles of air; the patient suddenly turns pale, utters a cry, and becomes insensible, or there is anxiety of countenance, labored respiration, lividity of lips, dilated pupils, and convulsions; syncope is often the predominant feature, and the patient may die with scarcely a struggle. The symptoms are developed according to the following conditions: (1) diminution of the aortic contents and loss of arterial tension, with acceleration of the heart, but no general symptoms; (2) more considerable loss of tension and accelerated respiration, with syncope, paleness, dilatation of pupils; (3) aortic current little or nothing, and excitation of the motor centres, with convulsive movements of the voluntary muscles, involuntary defecation and micturition, respiration slow, deep, apoplectic; (4) no arterial tension, death of the brain, with cessation of convulsions, then arrest of respiration, and, finally, stoppage of the heart's action.

The treatment is prophylactic and operative.[2] The following precautionary measures should be borne in mind: 1. The dependent position of the region of the body to be operated on tends to keep the veins full, and thus prevents the entrance of air. 2. Compression of the vein on the proximal side when it can be reached, as the external jugular vein, or direct compression when the vein is deep, as the internal jugular and axillary veins, may be resorted to with certainty of security against an accident.

It has been alleged[3] that the danger of this accident is imminent only when the wound is comparatively dry, as fluid in the wound effectually closes the orifice of the vein against air; a spongeful of warm water should be at hand, for use. The irrigation of the wound might be sufficient.

3. Ligation of a large vein which passes through a tumor, on both sides, affords absolute protection against danger. 4. An aseptic tampon should be introduced when the vein cannot be reached, and so graduated as to make accurate pressure. The operative methods are as follows: 1. Prevention of the entrance of more air is best effected by digital compression in the wound until a ligature is applied.

If the symptoms are urgent no time should be lost in securing the vessel until the patient has rallied from the immediate effects of air-embolism; it is also necessary to postpone the permanent closure of the vein until the time has elapsed for any indications to arise which would call for venesection or operative removal of the air from the right side of the heart, as in such case it may become necessary to utilize the wounded vein for the introduction of a catheter into the heart; in closing the vein the finger should not be removed suddenly from the vessel for fear of causing a repetition of the accident, but should remain until the vessel can be compressed on the proximal side of the vein-wound by an assistant.

If it is impossible to ligate the vein, the aseptic tampon must be retained. 2. The horizontal position is necessary to prevent cerebral anæmia, and cardiac stimulants by inhalation or subcutaneous injection may be required. The safety of the patient depends on the capacity of the right ventricle to force air through the pulmonary into general circulation; nitrite of amyl, which acts with rapidity in stimulating the heart, may be inhaled. 3. Venesection from the distal end of the wounded vein, while the proximal end is ligated or compressed, relieves over-distension of the right ventricle. 4. Removal of the air from the right ventricle by puncture with an aseptic needle.

---

[1] M. Couty. [2] N. Senn. [3] F. Treves.

It should be made as soon as possible after the entrance of the air if the primary effect of the heart embolus has produced sudden over-distension and paralysis of the right ventricle, indicated by immediate collapse and partial or complete suspension of the heart's action.

The puncture should be made in the left intercostal space, between the fourth and fifth ribs, about one and a half inches from the margin of the sternum; the needle should pass in an oblique direction from below upwards; externally it is connected with an aspirator which creates a vacuum as soon as the needle penetrates; the needle is advanced slowly until spumous blood appears when it is to be held firmly in this position and the contents of the ventricle removed as quickly as possible. To prevent air-embolism from wounds of the longitudinal sinus during operations the ligature may be first employed. Seize the exposed dura with a tenaculum at the outer margin of the sinus, and make a small incision with a tenotome parallel with the border, only dividing the dura; now seize the sinus walls with sharp-toothed spring forceps and draw it forward; pass an aneurism needle through one opening through the falx and out at the other. A second ligature may be applied in the same way and the sinus divided between them; in that case tie the peripheral ligature first.

CHAPTER IX.

THE MATERIALS FOR DRESSING WOUNDS AND THEIR APPLICATION.

I. EXTERNAL APPLICATIONS.

Collodion is the best application if the wound is very superficial and does not gape; or gauze may be added to give more support, as follows: Cut strips one or two inches wide, and three or four inches long, and with a camel's-hair brush moisten one end of the strip, which quickly dries and adheres; then treat the other in the same manner; when the wound is covered with the gauze, apply the collodion freely over the whole material, thus hermetically sealing the wound with a dressing impervious to water. Collodion dressings rarely require removal until the repair is complete.

Adhesive plaster answers best when bone underlies the wound, as in wounds of the scalp. The rubber plaster is the best as it adheres when it is wet. It should first be dipped in a solution of bichloride. Cut or tear the plaster in the direction of the length of the roll, and of sufficient length to extend two or three inches upon either side of the wound; compress the lips of the wound firmly when the strip is applied, as there is always a slight yielding of the margins, which may amount to a complete separation; the strips may be parallel across the wound, or so oblique as to cross each other. When the plaster is removed, great care is necessary to avoid disturbing the apposed surfaces; raise each strip equally from both ends to the margin of the wound, and turn it gently over on its axis, while extending each extremity.

II. KINDS OF SUTURE.

The materials of the suture must be selected with reference to the condition of the wound. If the margins lie in easy contact without any possible strain, select the prepared catgut; if they gape and cause some tension, use silk-worm gut, or prepared silk, or catgut, treated with chromic acid; if there is to be considerable tension, employ first sutures of relaxation, either the button, the quilled, or the twisted suture, which may be of prepared silk, wire, or silk-worm gut; if the wound is on the face horse-hair should be preferred. These various forms of suture are applied as follows:—

Fig. 45.

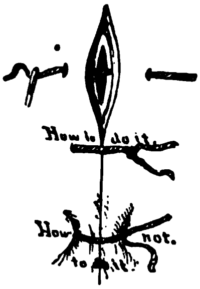
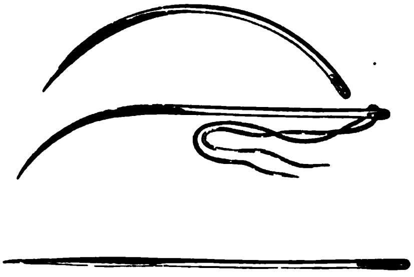


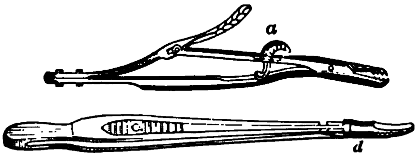
Fig. 46.



Ordinary needles.

The interrupted suture is made by approximating the edges of the wound at intervals, cutting the threads, and tying knots. Care should be taken not to tighten the knots so as to indent the margins (Fig. 45). Needles of various shapes are required (Fig. 46). The needle with curved extremity is more generally used; a needle curved throughout its entire length is useful when the wound is deeply seated; the straight needle with sharp point and cutting edges is serviceable in wounds on a slightly elevated surface; needle forceps are useful and should always be at hand (Fig. 47). If metallic sutures are used they may be inserted with the ordinary suture needle held by forceps.

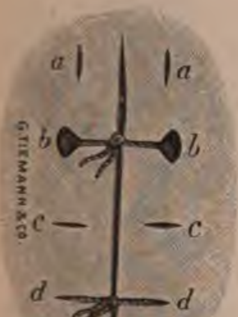
Fig. 47.



Needle holders.

A defect in the common surgical needle is that its incision is parallel with the wound, and when it is tightened the puctures gap (Fig. 48, *a*, *b*). This defect is obviated by a needle[1] which is flattened on its sides and which makes an incision at right angle with the wound. When traction is made on the suture the wound is closed (Fig. 48, *c*, *d*). They are made of every form necessary to meet the peculiarities of wounds. For the ordinary external wound they are of medium size and strength (Fig. 49); for sutures of the intestines they are slender (Fig. 50); for plastic operations they are stout (Fig. 51).

Fig. 48.



Wounds of new needle.

Fig. 49.

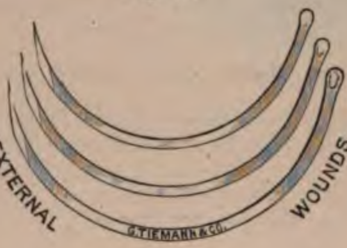
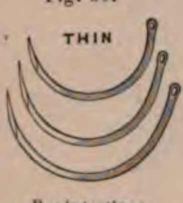
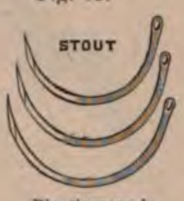


Fig. 50.



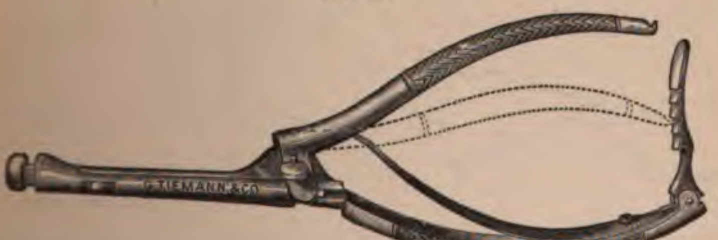
For intestines.

Fig. 51.



Plastic wounds.

Fig. 52.



Needle holder.[1]

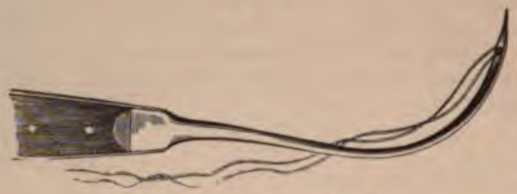
They are best employed with a needle-holder (Fig. 52). A needle fixed in a handle (Fig. 53) is necessary for the insertion of deep sutures of relaxation, or when the wound is in a depression as the perineum.

The distance between the sutures should not exceed half an inch,

---

[1] Hagadorn.

Fig. 53.

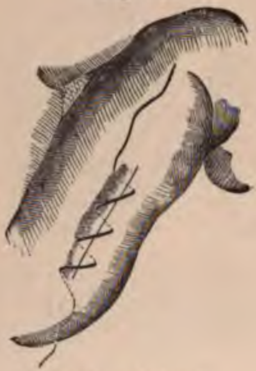


Mounted needle, armed with ligature.

and it is better, when silver wire is used, not to exceed one-fourth of an inch. Between wide sutures apply the continuous suture.

The continued, uninterrupted, or Glover's suture (Fig. 54) is now preferred in all simple wounds for coaptation of the cutaneous surfaces. It is inserted in the manner of the interrupted suture, but instead of being cut and tied at short intervals it is continued to the end of the wound when the knot is made with the free end of the double thread holding the needle (Fig. 55).

Fig. 54.



Continuous suture.

Fig. 55.

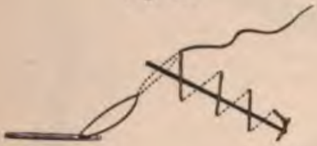


Fig. 56.

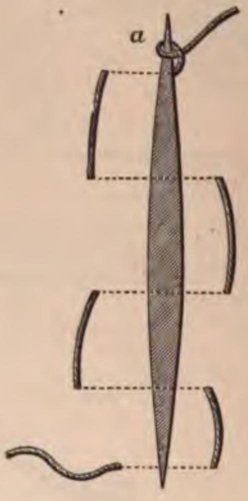
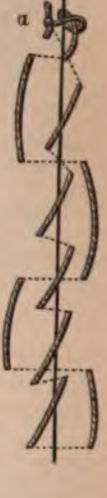


Fig. 57.



Suture of relaxation and coaptation.

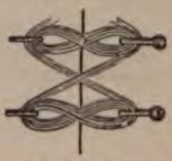
The following modification of the continuous suture[1] has the advantage of the deep retentive suture and the coaptation of the edges combined. Use a straight three-edged needle; begin at one end by a button suture, *a*, and apply the quilt or deep suture along the incision (Fig. 56), and then carry the thread back to *a* (Fig. 57) and tie the ends.

The twisted suture must be used when the wound involves deeper tissues and the surfaces are approximated with difficulty.

[1] Zesas.

Pass a needle of steel, silver, or other unirritating metal through the sides of a wound, as in the interrupted suture, and then twist the thread around the ends in the form of a figure-of-eight (Fig. 58); when several needles are required they should all be introduced before the thread is applied, which should then also take a diagonal direction between the pins to protect the intervening spaces.

Fig. 58.

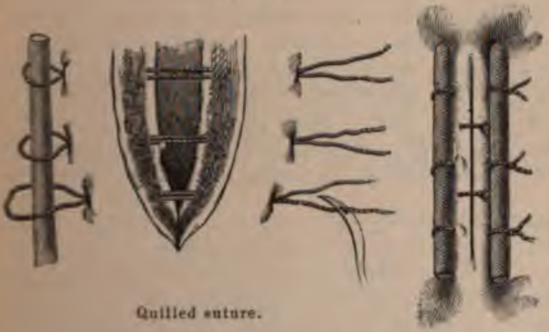


Twisted suture.

The quilled suture (Fig. 59) is to be preferred when the wound involves deep tissues; pass a double thread or wire as in the interrupted suture, but at greater distances, and tie the ends over quills or pieces of bougie laid on the sides of the wound; fine interrupted sutures should also be inserted in the intervals to sustain the skin in apposition.

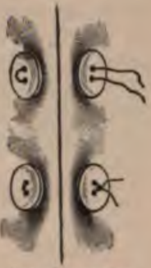
Button sutures are employed to relax the edges of the wound (Fig. 60), and thus leave the cutaneous margins free from the compression which must occur if they are tightly drawn together. The button may consist of a flat piece of lead cut of an oval form and of various sizes, perforated in the centre by a hole through which silver wire is passed, and provided with two lateral wings around which the wire is twisted.[1]

Fig. 59.



Quilled suture.

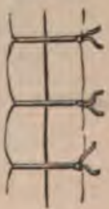
Fig. 60.



Button sutures.

The application of the suture is as follows: To unite opposing tissues which have been divided in the wounds, use the continuous catgut suture, as it will soften and disappear. For the cutaneous wound use the catgut suture unless there is some strain when the suture should be more durable, and silk-worm gut or catgut prepared with chromic acid, or Chinese silk must be employed. Two sets of sutures are very often useful in these cases; one, the suture of relaxation, being taken at a distance from the margins, and at considerable intervals (Fig. 61); the other, the suture of coaptation, is taken along the margins to nicely adjust the cutaneous edges, and may be continuous or interrupted. The button suture is often necessary to

Fig. 61.



---

[1] W. W. Cheyne.

approximate the deeper portions of the wound and thus act as relaxation sutures. The three forms of suture may all be applied to the same wound.

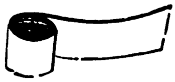
Strapping is now rarely employed; to render the strapping aseptic the straps must be immersed in warm carbolic lotion, 1-40.[1] The rubber adhesive plaster should be selected if at hand.

III. BANDAGES AND THEIR USES.

The bandage is that part of the dressing now employed exclusively for the retention of other appliances. Though simple in construction, and easy of application, it has proved a fruitful source of evil in the hands of the injudicious. The danger lies in undue compression of recently injured or inflamed parts, inducing mortification, especially of the extremities; cases have also been litigated for alleged atrophy and paralysis of the limbs resulting from its use. The materials selected must depend upon the purposes for which the bandage is employed. Where there is no wound muslin is generally selected of a coarse, unglazed quality. Flannel is useful when it is desirable to secure warmth. The cloth should be cut or torn into strips of one, two, or three inches in width, according to the part to which it is to be applied. Antiseptic bandages must always be selected if there is a wound. Those prepared in bichloride of mercury solution should be preferred. Only a few general rules of bandaging need be given here. Special forms of bandaging will be better understood if illustrated in connection with individual subjects.

The single head roller (Fig. 62) consists of a single piece. When applied to a limb, especially for compression, it should always commence at the extremity, and proceed upwards. Apply the first turns most firmly, in order to compress the superficial veins from below upwards; no one turn should be more firm than those below. The best general rule for its application is as follows: It should be done quickly, without pain, with ease, and with elegance.[2]

Fig. 62.



Single head.

Take the cylinder in the palm of the right hand, and with the thumb and fingers of the left seize the free extremity, drawing the roller out six to ten inches between the thumb and fingers of the right hand, the cylinder unrolling in its palm; place the external surface upon the limb, and retaining it with the first and second fingers of the left hand, pass the cylinder under the limb, and by the aid of the third and fourth fingers of the left hand make a turn or two to fix the initial extremity of the bandage. In continuing the application have but little of the bandage unrolled, keep the cylinder close to the limb, and pass it from one hand to the other without reaching with the respective hands beyond the centre of the limb.

The circular bandage (Fig. 63) passes nearly horizontally around portions of the limb of equal diameter, one turn overlapping the other at fixed intervals.

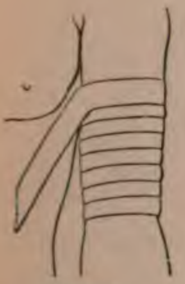
---

[1] W. W. Cheyne.

[2] Hippocrates.

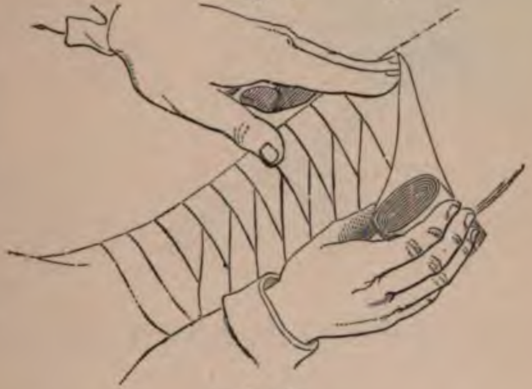
The spiral bandage (Fig. 64) ascends a more or less conical portion of the limb, each succeeding turn partially overlapping the other, with reverse turns on the more conical parts, as follows:—

Fig. 63.



Circular.

Fig. 64.

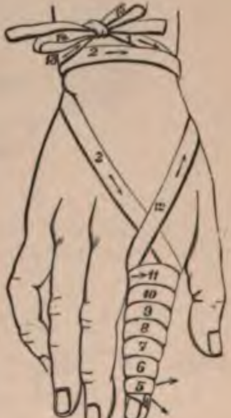


Spiral.

At the point where the roller ascends the limb so rapidly as to be irregularly applied, press the ends of the two forefingers of the left hand upon the upper fourth of the bandage, and retain it firmly at that point; then relaxing the bandage, turn the cylinder, held between the fingers and thumb, quickly and completely over, by pronating the right hand, thus applying the upper surface in turn to the limb.

It is applied to a finger as follows: Take a bandage an inch in width, and commencing at the wrist make a circular turn, leaving free two or three inches at the initial extremity (Fig. 65); then cross the back of the hand diagonally to the root of the finger to be bandaged; then along the palmar surface of the dry finger to its tip, where the spiral commences, with or without reverses according to the shape of the finger; when the finger is covered the bandage should pass to the side of the wrist opposite to that where it began, and be tied to the initial extremity. If it is required to bandage other fingers, instead of tying the two extremities, the bandage should pass around the wrist and across the back of the hand to the root of the finger, and be applied as above described. In this manner all the fingers may be bandaged with a single roller.

Fig. 65.

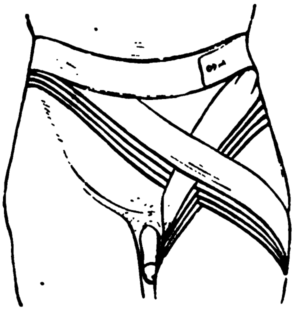


Spiral.

The Spica (Fig. 66) is applied on the upper part of the arm and thorax, of the thigh and pelvis, and of the thumb.

In applying it to the groin (Fig. 66) stand in front of the patient, place the initial extremity on his right side, and carry the cylinder circularly around the body twice, then carry it downwards and around the thigh, passing from the inside to the outside of the limb, then upwards around the body, crossing the downward turn in the groin. The first turn around the thigh should be as low as its upper fourth, and the subsequent turns should ascend regularly until the requisite pressure is attained.

Fig. 66.



Spica.

Fig. 67.

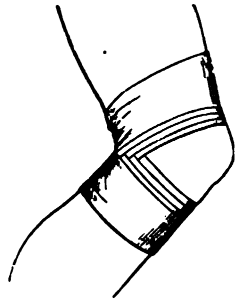


Figure-of-eight.

The Figure-of-eight bandage (Fig. 67) is generally applied about the joints.

At the knee, continue the bandages of the leg, after it has reached the lower border of the joint, by passing the cylinder behind the knee, obliquely across the ham to the opposite side of the limb, around the thigh, and downwards again obliquely across the ham to the point of departure; each successive turn should overlap the other until the knee is covered, or the object attained. If the figure-of-eight is applied to the ankle (Fig. 72), commence with circular turns around the foot, and then carry the cylinder obliquely upwards over the foot, around the leg, and again downwards around the foot.

Fig. 68.

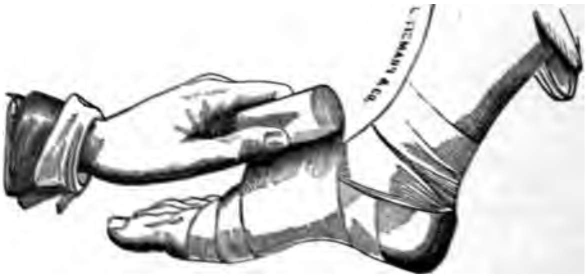
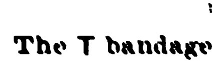


Figure-of-eight.

The double-headed bandage (Fig. 69) is applied as follows:—

Fig. 69.

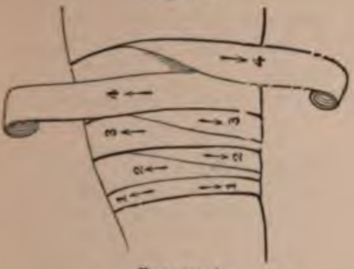


Double head.

Take the two cylinders in the hands, and, placing the outer surface of the central portion upon the anterior part, carry the two cylinders to the back part and exchange, then bring them forward (Fig. 70), and reverse, if necessary.

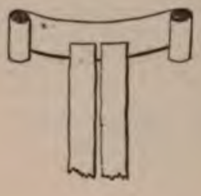
The T bandage consists of the simple bandage with one or two pieces added at right angles (Fig. 71), and is employed in the dis-

Fig. 70.



Recurrent.

Fig. 71.

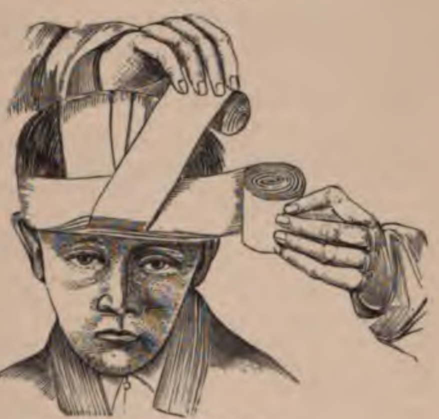


The T.

cases of the region of the perineum and anus. Pass the horizontal portion around the pelvis and firmly secure the vertical strips behind, after being passed under the perineum and the dressings.

The recurrent bandage should be five yards long and two inches wide; it is applied to the head as follows:—

Fig. 72.



Bandage for head.

The roller is first passed two or three times around the head in a line running just above the eyebrows and the ears, and below the occipital protuberance; next, at the centre of the forehead, the cylinder is reversed and carried directly over the head to the circular turns behind, where it is again reversed, and carried back to the forehead about one-third, as usual; these reverses to be continued until first one and then the other side of the head is covered; and the whole is completed by two or three firm circular turns as at the commencement; the reverses are to be held by the fingers of an assistant.

IV. THE FORMS OF PLASTIC APPARATUS.[1]

This form of appliance is required when operation-wounds are of such nature and location as to require absolute protection of the part from all motion. It must be applied with great care, and with due regard to the liability to strangulation of parts recently submitted to operation. By way of caution, it should be stated that all starch, chalk, and plaster-of-Paris splints contract on drying, and hence are liable to be followed by harm.[2] But though unfavorable results have followed its injudicious use, this dressing is invaluable when properly used.[3] The best safeguard against accidents is careful padding of the limb and parts adjacent to the wound with cotton-wool.[4] There must be constant watchfulness of the toes or fingers involved; if these parts become bluish-red, cold, or insensible, the dressing should at once be removed, or if the patient complains of severe pain under the dressing, it is well to remove it.[1]

---

[1] S. B. St. John. [2] T. Bryant. [3] T. Billroth. [4] Burggraeve.

The starch bandage is made with starch or dextrine as follows:—

Take common starch, a sufficient quantity, and boil it in water a few minutes. Dextrine is very readily prepared by thoroughly mixing with it spirits of camphor or brandy, 100 parts of the former to 60 of the latter, and adding about 40 parts of warm water. Envelop the limb with cotton wadding, so thickly applied as to cover all the prominences and fill the cavities; over this apply a roller well saturated with the starch; along the sides of the limb apply pasteboard splints of proper thickness, soaked in hot water, and nicely shaped to the limb; repeat the bandage twice, and saturate the whole with starch, rubbed in with the hands or a brush. When the starch is completely dry, cut out a piece, and bring the edges together with strong tapes, or leather straps with buckles; hasten the drying, by suspending the limb, or by applying hot bricks or bottles of hot water.

The gypsum splint is in many respects preferable to starch, and chiefly owing to the rapidity of its consolidation. It may be applied to a part of the circumference of a limb, or to the entire limb. When applied to a part of the limb as a splint, proceed as follows:[2]—

First shave or slightly oil the limb; next select a piece of old coarse washed muslin of a size so that when folded about four thicknesses it is wide enough to envelop more than half of the circumference of the limb, and long enough to extend from a little below the under surface of the knee to about five inches below the heel; select fine, well dried white plaster, and, before using, mix a small portion with water in a spoon and allow it to set, to ascertain the length of time requisite for that process; if it is over five minutes, dissolve a small quantity of common salt in the water before adding the plaster; more salt is added, the sooner the plaster will set; if delay be necessary, the addition of a few drops of carpenter's glue or mucilage will subserve that end; equal parts of water and plaster are the best proportions; sprinkle the plaster in the water, and gradually mix with it; immerse the cloth, unfolded, in the solution and saturate well; fold quickly, as before arranged, and lay it on a flat surface, such as a board or a table, and smooth once or twice with the hand in order to remove any irregularities of its surface, and then, with the help of an assistant, apply it to the posterior surface of the limb; turn up the portion extending below the heel on the sole of the foot, and fold the sides over the dorsum, and make a fold at the ankle on either side; apply a roller bandage pretty firmly over all; hold the limb in a proper position, extension being made, if necessary, by the surgeon, until the plaster becomes hard; the time required in preparing the cloth, mixing the plaster, and applying the casing to the limb need not be more than fifteen minutes.

When the dressing is to inclose the limb completely, all the details of preparation and application must be carefully attended to in order to insure safety and success. The following method[3] secures a neat and serviceable dressing:—

Select clean cotton batting, smooth and fresh plaster of Paris, and the flimsiest cotton-cloth, as crinoline, which tear into strips of two and a half or three inches in width, make one strip nine to twelve yards long, and the remainder three yards long; lay the latter on a kitchen table or board, and have the plaster well rubbed into the cloth; roll them into cylinders; into an ordinary washbasin, one-third full of water a little warm, put two heaping tablespoonfuls of powdered alum; have the whites of half a dozen fresh eggs beaten into a froth; unfold the batting carefully, that it may be in a sheet rather than a roll, and envelop the whole limb, covering well the bony prominences; secure the cotton with the long roller, into which no plaster has been rubbed; put the plaster rollers into the basin of water; squeeze and press them with your hand until well wetted; apply them to the limb, one after another, until the dressing is sufficiently firm; three layers are usually required; the rollers may be put on longitudinally instead of circularly; make no reverse turns of the bandage, as they are unnecessary, and give the dressing a clumsier appearance than it otherwise would have; smooth each layer of bandage nicely with the hand, which will add to the firmness of the dressing and make it dry more quickly; wait a few moments for the plaster to dry; the alum added to the water will greatly facilitate this; when comparatively dry apply the whites of the eggs over the plaster; then apply a roller without plaster over this; or cut the roller into strips and lay them along the length of the limb; the egg prevents the plaster from chipping; the additional roller assists this, and gives to the dressing a finish which it does not otherwise have.

---

[1] T. Billroth.

[2] J. L. Little.

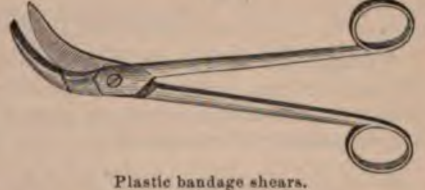
[3] D. W. Yandell.

The gypsum may be applied to the bandage by means of an apparatus consisting of a tin pan with a roller.

Pass one end of the bandage under a rod and attach it to a roller; put the plaster on the bandage, turn the roller, and as the bandage passes under the rod the plaster is evenly applied.

In removing the dressing which encircles the limb, it must be cut down in the middle line with a sharp-pointed knife or with shears made for that purpose (Fig. 73).[1]

Fig. 73.



Plastic bandage shears.

The silica bandages[2] are made of the silicates of potash and soda dissolved in an excess of caustic alkali. They form a cheap and efficient fixed dressing, which does not contract in drying, and is very light and clean.

Apply it as follows: cover the part with cotton-wool, lint, or a thin flannel roller, and apply over this a common dry bandage; with a brush or sponge apply a coat of the silicate; repeat the bandage and silicate until two or three layers cover the limb; when the last layer is dry, put on another coat of the silicate so as to give an even surface; expose the limb to the air for about half an hour, when the bandage will be firm enough to prevent movement; the bandage continues to harden for about two or three days. To give greater strength to the bandage, mix whitening with the silicate in sufficient quantity to give the consistence of batter.[3] A rapidly setting and extremely firm splint may also be procured by covering the limb with cotton-wool, lint, wool, a worsted stocking, or any soft protecting material, and apply strips of linen, bandage, or paper saturated with silicate of soda mixed or not with a salt of lime, such as chalk, whitening, or plaster of Paris.

[1] G. W. Wackerhagen.

[2] W. W. Wagstaffe.

[3] W. C. Elliott.

CHAPTER X.

THE APPLICATION OF THE PRINCIPLES OF ANTISEPTIC SURGERY.

THE practical application of the principles of antiseptic surgery requires the proper employment of agents which have the power of destroying, or of rendering inert, the micro-organisms which enter the wound and cause putrefaction, but which are themselves as little disturbing to a wound as possible. It follows that the surgeon who successfully applies the principles of antiseptic surgery must intelligently recognize both the indications for the use of antiseptic agents, and the special adaptation of these agents to accomplish the object in view. The indications as now understood and defined, and the agents that are now more generally relied on, are as follows:—

I. DISINFECTION OF THE AIR.

Though the spray is still in use by some surgeons for disinfecting the air of rooms, and around wounds when cavities are opened, it is no longer regarded as a necessary part of the antiseptic treatment by the larger number of operators.

Of all the precautions that of purifying the air by means of a carbolic acid spray is the least necessary, for there are but few septic particles present in the atmosphere, and even though some of them fall on to a wound they may be rendered inert by washing the wound with carbolic or sublimate solution.[1] Carbolic acid[1] is generally employed, as spray, to purify the atmosphere; this is obtained by driving a rapid current of air or steam through a horizontal tube so as to pass over the orifice of a more or less vertical one; a vacuum is produced in the vertical tube, and the fluid at its lower end rises, and is expelled from the orifice in the form of spray. When the hand sprays are employed 1-40 solution is placed in the bottle; in the steam spray the 1-20 solution is used, because, the steam, mixing with the solution, reduces its strength to 1-30 or 1-35.

An apparatus which effectually meets the indications should give a spray as fine as the lightest fog, and continue for a sufficiently long period without interruption or accident.

II. DISINFECTION OF THE OPERATOR, ASSISTANTS, AND PATIENT.

Too much importance cannot be attached to the cleanliness of those who are to manipulate the wound, and of the surfaces to be operated upon. The primary source of wound infection has hitherto been the hands of the operator and his assistants. Of the truth of this statement no surgeon can doubt who will during one day note the uses of his hands, the number of times he washes them, the soiling of the water he uses for that purpose, and the constancy with which filth is found under the nails. This proof will become more striking if he is engaged in hospital practice, for he will learn that his hands have been in contact with infectious matters many times, though perhaps quite unconsciously.

---

[1] W. W. Cheyne.

The hands of surgeons differ as to their susceptibility to cleanliness; some have very smooth hands and fingers, to which filth clings with difficulty; while the hands of others are always rough, often fissured, and always tend to accumulate foreign matter. We may, undoubtedly, attribute much of the success of a class of surgeons who, without special attention to the details of antiseptic methods, or in defiance of them, obtain uniformly good results, to naturally smooth hands and habitual care to have them and the nails scrupulously clean. Such operators are instinctively attentive to all the conditions which secure cleanliness of the wound, viz., clean assistants, clean instruments, a clean patient, and clean dressings.

Scarcely less important is the thorough cleansing of the surfaces about to be operated upon and parts adjacent. The patient should, if practicable, have a full hot bath, with soap, several hours before the operation. At the time of the operation the immediate surfaces about to be involved should be cleansed with soap and water, and shaved with a razor, in order that all hairs may be removed.

The difference between the limbs of a patient, one of which has been prepared for an operation, and the other has not been disturbed, is often very striking, and forcibly illustrates the importance of the antiseptic method of securing a clean patient.

Bichloride of Mercury, 1–500, is the agent now relied upon to destroy any infective matter which still adheres to the cleansed surfaces. This is applied freely to the hands and arms of operator and assistants, and to the parts about to be engaged in the operation. The carbolic acid solution was formerly used for these purposes, and is still preferred by some surgeons. But it has marked disadvantages as compared with the sublimate solution, in this, that it irritates surfaces, benumbs the hands of the surgeon and assistants, and is not as effective as the sublimate.

In a series of experiments[1] to determine the comparative values of different methods of rendering sterile the bacterial dust which is always present on the hands, corrosive sublimate solutions alone, of a strength of from one-half to one part in one thousand, were found to be efficient, and the finger thus treated, when dipped in the most sensitive culture media, induced therein no fungous growth. Even with this care to cleanse the skin it is by no means certain that all micro-organisms are destroyed, especially on parts of the body liable to fetid secretions or excretions. In operative procedures[2] on the axilla and scrotum, for example, all preliminary washings and disinfection are impotent to exterminate the micro-organisms that exist in the openings of the glands to a depth of one-fourth of an inch and more. None of the proceedings in use in antiseptic surgery is of any avail to destroy them, they will continue to grow and reach the surface, and unless we maintain there a storehouse of disinfectant material, frequently renewed, that will suffice to saturate all discharges and convert them into aseptic fluids, we shall assuredly find the organisms under our dressings. Iodoform and salicylic acid, which are treasure-houses of disinfection, are more useful in those regions than on the arms, legs, and hands; but even in these purer territories over-confidence is perilous, and where we are dealing with skins not regularly cleaned, as is the case, for instance, to a large extent, in hospital practice, we have to add to our habitual precautions, and attend both to preliminary saturation of the epidermis with penetrating disinfectants and the subsequent maintenance of stores of disinfectants on the surfaces where the germs may develop and appear.

---

[1] Forster.

[2] A. Ogston.

III. ANTISEPTIC SOLUTIONS TO BE USED IN AND ABOUT THE WOUND.

Antiseptic solutions must be employed in the wound to protect the surfaces from the action of infective matters which are liable to reach them during the operation.

Bichloride of mercury is the most available agent now employed to render inert and innocuous the organisms which infect wounds from whatever source while the operation is in progress. It is odorless and does not irritate wounds, and when judiciously used is devoid of danger. It may create slight roughness of the hands, and mild eczema, and if applied of too great strength to large wounds, or if retained in cavities, constitutional effects may follow. For ordinary uses a solution of 1–1000, about sixteen grains of the salt to a quart of water, will prove most useful. If it is to be applied by irrigation to a large wound add a quart of water to the previous solution, reducing the strength to 1–2000; or if it is to be injected into cavities which may retain a portion, reduce the strength, by adding water, to 1–5000 or 1–10,000. For external uses the strength may be 1–500.

Carbolic acid was formerly used exclusively, and is still preferred by some surgeons, but it has been superseded by corrosive sublimate in the practice of most surgeons. The following rules are given[1] which will be useful to those who still prefer, or may have occasion to employ carbolic acid: 1. *The two and a half per cent. solution is used, almost exclusively*, for washing hands, irrigating wounds, moistening dressings, syringing out drainage tubes, moistening absorbent cotton, cleansing wounds when dressings are changed; instruments and tubing are put into it before the operation, sponges are handed from it in all operations except in laparotomy. 2. *The one per cent. solution* is employed for sponges and napkins as in laparotomy; it is also used for irrigation in operations on the rectum, in the vagina, on the bladder and urethra; and also in case of wounds in the neighborhood of the peritoneum, in order to avoid carbolic acid intoxication. 3. *The five per cent. solution* is used to render aseptic wounds and ulcers into which injurious substances have penetrated (for this purpose weaker solutions are insufficient); for example, from the very first in complicated fractures with begrimed wounds, in order to obtain healing by first intention; also subsequently in case of fever and suppuration, to syringe out the wound through the tubes before one decides to remove the stitches. 4. *A ten per cent. carbolic glycerine* is also in use, besides the aqueous solutions; in this lie the metallic catheters, which are in constant use, and the uterine sounds (in separate glass cylinders), which must be thoroughly washed with two and a half per cent. carbolic solution before being used, so as not to irritate. The same course is adopted for silver wire, buttons, and bullets, which are always in carbolic glycerine, and for blunt laparotomy instruments, clasps, etc., which are in it during the twelve hours preceding the operation. 5. *Five per cent. carbolic glycerine or vaseline* is used on the fingers for examinations in the vagina or rectum.

---

[1] V. R. v. Hacker, Billroth's Clinic.

IV. MATERIALS TO BE USED IN THE WOUND.

The most scrupulous care must be taken that all materials which come in contact with, or which must remain in wounds, are entirely free from all irritating and disturbing qualities.

The instruments, however they may have been cleaned and preserved, must be immersed in carbolic acid solution, 1–30, at least fifteen minutes before the operation, and during the operation they should be at once placed in the solution when the surgeon ceases to use them. Corrosive sublimate solution should not be employed, as it destroys metals.

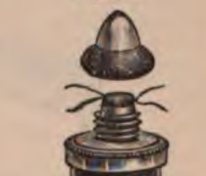
Sponges should be carefully selected, a fine quality of reef sponges being preferred. Prepare them as follows:[1]—

Cleanse them first by beating out the sand; then to one gallon of water add eight fluidounces of a saturated solution of permanganate of potassium, put in half a pound of sponges; in another vessel put a gallon of water, adding to it three fluidounces of concentrated hydrochloric acid and one ounce of hyposulphite of soda; the sponges having lain in the permanganate solution fifteen or twenty minutes, remove them singly, squeezing them as dry as possible, and place them into the acid and salt solution; replenish this solution when the last sponges fail to turn white; take out the bleached sponges, squeeze them, and put them where they will become as dry as possible; now put those needed for immediate use into jars containing a 1–30 carbolic acid solution; at the operation a few of these are taken from the jar, squeezed out and thrown into a bowl with 1–2000 bichloride of mercury solution. Flat sponges and other valuable varieties may be re-cleansed and used repeatedly thus: wash out all blood and other substances as thoroughly as possible, put the sponges into a bowl of clean water in a warm place; as soon as decomposition has broken down the fibrin which lurked in their pores, wash them again and bleach them as before directed.

Metallic sutures are readily made antiseptic[2] by immersion in carbolic solution.

Silk-worm gut is stronger than silver-wire of the same thickness, and is very flexible; it is unirritating to the tissues, and is never absorbed; it should be kept ready for use in a 1–30 carbolic acid solution.

Fig. 74.



Antiseptic ligatures.

The silk thread comes in all sizes, and is either twisted or braided. To make it antiseptic it is boiled for one-half hour in a five per cent. solution of carbolic acid. The spools (Fig. 74) on which the silk is run, must have been previously boiled in a like solution. If the silk is to be used soon, it is placed in a bottle containing a three per cent. solution of carbolic acid; but if the silk is to be stored it is rapidly dried, run on spools previously dried, and packed in air-tight cases. These spools may be of glass.

Disinfected silk[2] takes the place of catgut under all circumstances; sutures and ligatures are made from it; seven sizes are used, number one being the coarsest and seven the finest; two and three are used for the strongest ligatures and single sutures, four for stronger ligatures and deep sutures, five for common ligatures and sutures, six for fine sutures.

---

[1] R. T. Morris.

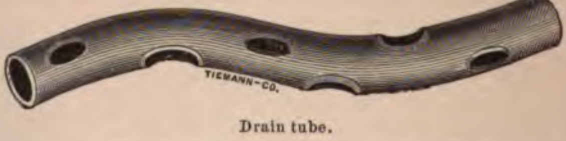
[2] V. R. v. Hacker, Billroth's Clinic.

Catgut is very useful for general suturing and ligating purposes. Raw catgut is prepared antiseptically thus: put the skins in a bottle full of oil of juniper, leaving them there for two or three days, by which method the oil of the gut is dissolved; empty out the oil and rinse the skins in alcohol, this eliminates all the oil; put the skins in a wide-mouthed bottle filled with commercial alcohol, and keep them there till required for use. Chromic acid renders catgut very durable.

Care need be taken not to cut the free ends of the gut too closely to the knot; for fastening the free end of the gut after taking the last stitch in a continued suture, leave two inches of free end when you cut off the surplus part of the strand; run the needle and surplus part of the strand once more through the skin in the usual interrupted suture way; tie the interrupted suture with a square knot with the free end of the continued suture gut; catgut is usually completely absorbed by the end of the tenth day after its introduction into the tissues, and sometimes the smallest size disappears during the first week.[1]

The drains of a wound are of great importance, for if the effused plasma is allowed to accumulate it is likely to create inflammation by its tension, and also to undergo putrefactive changes. The materials used for drains must be of an unirritating quality, and be rendered aseptic by bichloride solution before their introduction. The rubber tube (Fig. 75) is useful where it is not liable to such compression as to close its calibre. Select a tube of the proper size, and cut it of the requisite length; also cut, with scissors, several holes along its sides to allow the free escape of the fluid into its interior; attach a string to its external extremity, or stitch it to the skin and insert it to the bottom of the wound; remove it within four days and do not reinsert unless there is a discharge. Decalcified bone makes an absorbable drain,[2] which renders it unnecessary to change the dressings to remove the tube.

Fig. 75.



Drain tube.

These are tubes drilled in long bones and then decalcified and carbolized; holes are afterward cut in the sides, and they are used like ordinary India-rubber tubes. Chicken bones[3] are prepared as follows: The tibiæ and femora are scraped and steeped in hydrochloric acid and water (one to five) until they are soft; their articular ends are then snipped off with a pair of scissors; the endosteum is raised at one end and pushed through to the other extremity, along with the contents. They are then introduced a second time into a fresh solution of the same strength, until they are rendered a little more pliable and softer than is ultimately required (as they afterward harden a little by steeping in the carbolized solution). When thus prepared, they are placed in a solution of carbolic acid in glycerine, 1–10; can be used at the end of a fortnight from the time of introduction into the glycerine; these tubes are threaded with horsehair before being introduced into the tissues, which help to maintain the calibre of the tube during the first few days and also act themselves by capillarity. If a tube is required for a period over eight or ten days, it can be obtained by steeping the decalcified tube in a chromicized instead of a carbolized solution, which resists absorption for two or three weeks.[1]

---

[1] R. T. Morris.

[2] Neuber.

[3] MacEwen.

Catgut drains well, and is finally absorbed, rendering frequent renewal unnecessary, but may swell too much, and become so incorporated with the tissues as to cause bleeding, when removed. Horsehair makes a cheap and efficient drain, and has the great advantage that it can be reduced in bulk at any time without disturbance, by drawing out as many hairs as may be desired; the hair should be treated with carbolic-acid solution, 1 to 20, and may be introduced with forceps, or with the eye of a probe; it may be removed in whole or in part by withdrawing one hair after another. If it is necessary to re-introduce the drain, take a wisp of hair half the size required, bend it in the middle at a sharp angle over the probe, tie a piece of carbolized silk around it close to the probe, on withdrawal of which the drain is left with a rounded end which passes readily into the interior of the wound.

Canalization[2] is a process by which good drainage is afforded to a wound without the use of drainage-tubes. There are two kinds, shallow and deep canalization. The first is employed for draining extensive subcutaneous cavities, situated beneath large skin flaps. It is accomplished by the aid of a punch, similar to the common leather punch, the hole which it makes being elliptical. Any subcutaneous fat which protrudes through the opening made by the punch is to be removed with scissors. As many holes as will suffice to carry away the secretion are made through the dependent portion of the wound. If the wound is extensive, it is well to scatter a number of holes over the entire flap covering the wound. Deep canalization is used to afford drainage to accumulations in the recesses of deep wounds, where intermuscular planes are opened up, and the dangers of retention and suppuration are more grave than in the case of shallow wounds. In deep canalization the skin on both sides of a deep wound is detached so as to make it movable; it is then turned into the bottom of the cavity and fastened with catgut sutures. In this way the greatest portion of the cavity becomes lined with skin, and it can heal by adhesion, the funnel of cutis serving at the same time as an unobstructible channel for draining the bottom of the cavity.

V. THE IMMEDIATE DRESSINGS OF WOUNDS.

The immediate dressing of a wound must be selected with a view to irritate as little as possible the young epithelium by the materials in contact with the surface. Formerly, when carbolic acid solutions were used, which are very irritating, and external dressings were impregnated with this material, a protective was applied directly to the wound to prevent its irritation by the acid. The protective should still be used if the carbolized gauze is employed, but if the iodoform gauze is used the protective may be dispensed with. The latter method is much to be preferred.

The protective[1] consists of oiled silk coated with copal varnish. It is prepared by brushing over the surface a mixture of one part of dextrine, two parts of powdered starch, and sixteen parts of cold watery solution of carbolic acid, 1–20.

---

[1] W. W. Cheyne.

[2] Neuber; A. Gerster.

Iodoform is now usually preferred to carbolic acid; it is not irritating when dusted over the surface of wounds, whether closed or open, before other dressings are applied.

It may be used thus:[1] first, as powder, to dust finely upon wounds wherever the iodoform gauze cannot be employed, as on the palate, in the throat, and the like, or when more iodoform is desired in direct contact with the wound, as after curetting. Secondly, in preparation of the common absorbent iodoform gauze, and of the adhesive used in the mouth. Thirdly, as iodoform-glycerine, mixed and shaken with glycerine (10–20 : 100) for injecting cold abscesses, etc., after evacuation of the pus by puncture or incision. Fourthly, as iodoform-collodion, when it may be used with great advantage instead of a dressing in small superficial perfectly closed wounds, as on the face; it is simply painted over and about the wound to a distance of one centimetre from the edges, after the wound has closed and ceased bleeding; this last condition is important; the bloody points between the stitches must be washed off with small sponges; with this provision the wounds heal under it very beautifully, without irritation and without the least suppuration about the stitches; after six or eight days, the pellicle which has been formed may be removed as a whole with the several sutures, the holes left by these may again be painted with the solution and the exfoliation of the collodion be left to itself. Fifthly, it is used as iodoform-vaseline, when an ointment is desired, as on ulcers.

If a large amount of iodoform (four to eight drachms) be used on an open wound, toxic effects, marked by continued mild delirium, a rapid feeble pulse, and a remittent temperature running up to 102° Fahr., may supervene; in cases of poisoning by iodoform the symptoms usually disappear rapidly if the unabsorbed portion be removed.[2]

Boracic acid[3] may be employed with advantage when the wound becomes quite superficial; there are various preparations—

First, boracic lotion, a cold saturated solution of boracic acid in water; it is soluble in 25 to 30 parts of water, and in very much larger proportion when the water is boiling; it is convenient to tinge this solution with litmus in order to distinguish it from carbolic lotions; *secondly*, boracic lint is ordinary surgical lint soaked in a hot saturated solution of boracic acid and then hung up to dry, about half its weight consisting of crystals of the acid; *thirdly*, boracic ointment is sometimes employed, two strengths generally being used, called full strength and half strength, the former being applied to wounds where cavities exist and the latter to superficial wounds, which are desired to heal rapidly. The original formula for full strength ointment is as follows: boracic acid crystals one part, white wax one part, paraffin two parts, almond oil two parts; the half strength contains half the quantity of boracic acid.

Salicylic acid cream[3] is used around the wound when a dressing is to be left for some days to prevent irritation by the discharge.

It formerly consisted of salicylic acid crystals mixed with 1–20 carbolic acid lotion in sufficient quantity to form a creamy fluid, which is apt to separate into two layers, and therefore it is better to make a cream by mixing salicylic acid with glycerine, forming a paste; the cream remaining of uniform consistence is easily applied.

There are many other agents having antiseptic qualities, but their value in practice has not been determined; they will be noticed in connection with individual operations.

---

[1] V. R. v. Hacker, Billroth's Clinic.

[2] V. R. v. Hacker.

[3] W. W. Cheyne.

VI. THE EXTERNAL DRESSINGS OF WOUNDS.

Simplicity is not more important in the mediate than in the immediate dressings of wounds. It is better to apply nothing at all than too much. But the wound must be preserved in a state of complete protection and repose, and in order to secure that, additional dressings are often required, both to support the first and to maintain the parts in a condition of rest. These should be selected and applied so as to preserve cleanliness, allow free circulation in the vessels, be easy of removal and reapplication, and yet fulfil their special purposes. The special form of dressing must be determined by the nature, conditions, and peculiarities of each individual wound, and the method of repair which is sought to be obtained. Only general rules concerning the dressings of wounds antiseptically can be properly considered in this place; the special forms of dressings will be described in considering the details of antiphlogistic treatment.

Iodoform gauze is one of the most useful external dressings employed. It is prepared as follows: Bleached cheese cloth is irregularly laid together in a disinfected receptacle, viz., a washbasin cleaned with carbolic acid, and sprinkled with iodoform powder by means of a dredger; the powder is then carefully rubbed in with the disinfected hand till the gauze is uniformly yellow, that is, is uniformly impregnated with it; then the excess of iodoform is removed by shaking, and the gauze, now ready for use, is kept in shallow glass vessels which can be closed; the amount of iodoform contained in this gauze varies according to the shaking from ten to twenty per cent.

This gauze[1] is employed for the direct covering of all wounds except those in the mouth, being applied in layers to closed wounds and in strips to cavities; it absorbs readily, hence never causes retention of the discharge; it does not irritate, like carbolic gauze, and does not easily produce iodoform intoxication. An adhesive iodoform gauze may be made thus: Bleached cheese cloth is moistened throughout with an alcoholic solution of resin, to which about half as much glycerine has been added, dried, and then impregnated with iodoform as the absorbent iodoform gauze is. For six metres of gauze there are required two hundred and fifty grammes of iodoform; one hundred grammes of resin are dissolved in twelve hundred grammes of ninety-five per cent. alcohol, and fifty grammes of glycerine then added; where carbolic gauze is prepared in large quantities, the adhesive iodoform gauze may be made by impregnating carbolic gauze with iodoform. It is used as a dressing for wounds in the mouth, and as a hæmostatic in cases of parenchymatous hemorrhage.

Carbolic gauze may be used directly over the layers of iodoform gauze, which cover the wound, in dressings which are to remain a long time; on the one hand, to hinder the decomposition of the discharge in the outer layers of the dressing; and on the other to furnish a material in which the fluids diffuse themselves better than in absorbent cotton.

Two thousand grammes of resin are dissolved in twelve litres of ninety-five per cent. alcohol; to this five hundred grammes glycerine and five hundred grammes crystallized carbolic acid are added, and the whole well stirred; by means of several rollers, two hundred metres of cleansed gauze are wound upon a wooden apparatus, and then saturated with the above solution, spread out, and again, in a saturated condition, wound up; that the wet gauze may dry more quickly, it is rolled on a second reel, after the carbolic acid solution has dripped off and has been wiped off, and thus evaporation hastened; the gauze remains on the reel till it is dry, as a rule twenty-four hours being required for two hundred metres; now the gauze is ready for dressings; it is cut into pieces a metre long and kept in tin boxes which are always freshly washed out with carbolic acid before being used; this treatment requires, as a rule, two to two and a half hours. For preparing the gauze only the chemically pure carbolic acid is used; and the tin boxes must not be kept in too cool places, for then the carbolic acid separates here and there in crystals from the gauze, and may cauterize the skin.

---

[1] V. R. v. Hacker, Billroth's Clinic.

Absorbent cotton is used first directly over the layers of iodoform gauze, in two or more layers, but only in dressings which are to remain a short time; if these remain a week or longer, the discharge decomposes in the outer layers of the cotton, but without the least injurious influence on the wound or the course of healing; but, because this absorbent cotton gives out an annoying cheesy smell, use the carbolic gauze for this purpose; secondly, use the impermeable material, in strips, a handbreadth wide, to close the dressing, and also in irregular layers to exert elastic compression at certain places; thirdly, in dressing about the face, eyes, ears, etc., to protect against pressure; fourthly, as simple tufts, and as scraps dipped in two and one-half per cent. carbolic acid solution and wrung out, the former in general use for cleansing wounds, the latter for special use in the vagina and rectum.[1]

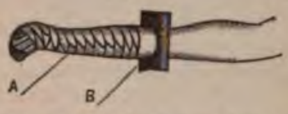
Cotton,[2] employed for antiseptic purposes, must previously have been rid of its oily substance. This is done by boiling in a solution of caustic soda or potassa for twelve hours, the cotton well washed and dried. *a*. The cotton may be prepared by impregnation with a solution of carbolic acid from 2½ to 5 per cent. and used immediately. *b*. Borated cotton is prepared thus: Take from 10 to 20 parts of boric acid and from 90 to 80 parts of warm water at 120° F., immerse the cotton and apply it wet, or dry, and carefully store it for use in closed vessels. *c*. Salicylated cotton is made as follows: Salicylic acid, 3 parts; alcohol, 30 parts; glycerine, 4 parts; water, 300 parts. All is heated to 160° F.; 100 parts of cotton are immersed, dried, and stored as above. Salicylated cotton of 10 per cent. is made in the same way, only with increased proportions of all parts. *d*. Iodoform cotton is made thus: Dissolve iodoform, 4 parts, in the following: Ether, 20 parts; ol. fennel, 1 part; dil. alcohol, 40 parts; glycerine, 20 parts. Into this immerse 40 parts of cotton, which now is rapidly dried. As iodoform quickly evaporates, it is best to prepare when wanted. It may also be prepared by pouring the solution upon a plate, immersing the cotton, allowing about 15 minutes for its saturation, and is then used at once.

Gutta-percha[3] is a very thin, flexible, water-proof material possessing a wide range of usefulness. About the head, in which the irrigating solutions or blood may run in the eyes or through the hair of the patient, a wide strip of gutta-percha tissue can be fastened by one margin to the skin of the forehead, so that the remainder of the hair will fall over the parts to be protected; to prevent rapid evaporation from the skin, and for purposes of general neatness in abdominal operations, a large sheet of the gutta-percha tissue is fastened to the abdomen, a sufficiently large hole is cut in the centre of the piece before applying, and the margins of the opening that surround the operative field. When an injured limb is to be elevated, and permanent irrigation employed, the gutta-percha tissue is invaluable; a piece being fastened about the limb in such a way that water is prevented from running down along the limb toward the body (Fig. 76). When used about fresh wounds it should be washed in bichloride solution.

---

[1] V. R. v. Hacker, Billroth's Clinic. [2] C. Am Ende. [3] R. T. Morris.

Fig. 76.



A. Loosely bandaged gauze dressing.
B. Gutta-percha tissue.

It may be fastened to the skin by dissolving a mass in chloroform which, in a few minutes, may be applied by a camel's-hair brush along the skin where the margin of gutta-percha tissue is to be attached; apply the margin to be attached, wait a moment for softening to take place, and add fresh narrow strips along the soft sticky edge.[1]

CHAPTER XI.

THE CONDITIONS AND DETAILS OF AN ANTISEPTIC OPERATION.

WHATEVER importance may be attached to the manual of the operation, it is usually insignificant in its bearings upon the final results, when compared with the measures employed to protect the wound from septic poisons. These measures should be carefully taken according to the latest and most approved authorities, and should govern every step in the operative procedure, and in the treatment of the wound, until the case is completed.

The immediate preparations for operations must be complete in all of their details, and, as far as practicable, should be personally supervised by the surgeon or a trained assistant. These preparations will vary with the nature of the operation and the circumstances under which it is to be performed. The maximum of preparation should always be found in the operating rooms of hospitals. Here operations of every variety are performed; many of them are in cases of emergency, and they are liable to occur at all hours of the day and night. It becomes a matter of necessity that every form of apparatus, and every variety of dressing and appliances, should be constantly on hand and ready for use. As a consequence, the responsibilities of the hospital surgeon are greater than are those of the surgeon in private practice. His obligations to his patient increase as his facilities for securing success multiply. He cannot successfully plead the want of materials adapted to meet the necessities of any given case, for the reason that he is culpable if, at the critical moment, they are not in readiness and available. Hence, it is of great importance that every hospital, having a surgical service, should have its operating room not only thoroughly equipped with instruments and every necessary appliance, but the room, the instruments, and all of the materials employed, should be in the condition best adapted to insure success.

---

[1] R. T. Morris.

The operating room and its equipment (p. 91) are parts of the general appointments of the hospital, for its location, construction, good sanitary condition, and provision the surgeon is especially responsible. The room should be convenient of access, and yet so located as to be abundantly supplied with absolutely pure air and sunlight. To this end it should be so separated from the wards and from the administration of the hospital as never to receive the air of these departments, nor the effluvia of drains, nor the waste materials which may accumulate on the grounds and in outbuildings. In construction the materials of the walls and of the necessary furniture should be such as will, in the least possible degree, absorb and retain filth in any form, and will admit of thorough cleansing. The best sanitary condition must be maintained by daily rubbing of walls, floors, and furniture with disinfectant cloths, and by frequent fumigation with sulphur or chlorine gases in great abundance.

In private practice the surgeon is placed at a comparative disadvantage. He may have no knowledge of the nature of the operation which he is called at a distance to perform, nor the emergencies which he may be compelled to encounter; nor may he be able to modify materially the conditions under which the operation is to be performed. These circumstances greatly modify the responsibilities of the surgeon in his public practice when contrasted with his private practice; in the former he must have the maximum; in the latter he might not be censurable if he had the minimum of preparation.

In giving the details of the antiseptic method it will be more instructive to select from hospital practice a case demanding an operation of recognized severity, and which requires for its successful treatment careful attention to all of the peculiarities of the system of antisepsis. In this description will be given the ordinary antiseptic arrangements of the operating-room, and the method of employing the materials. This will afford an opportunity of explaining the necessary variations of private practice. The operation selected is excision of the knee-joint.

I. THE ARRANGEMENT OF MATERIALS.

The instruments are selected and assorted in different pans, arranged on a convenient table (Fig. 80). These pans are shallow, and may be tin or earthen. They are partially filled with carbolic acid solution 1.20. In *A* are placed all of the cutting instruments, scalpels, bistouries; in *B* are all of the blunt instruments, forceps, scissors, directors, probes, the bone-forceps and retractors; in *C* are bone-drills, silver wire, and needles. In private practice, with perhaps one assistant, the instruments should be placed on a stand so near the operator that he can personally take them from the solution and return them to it. He will experience but very little inconvenience in this arrangement.

The ligature and suture thread is kept on reels in bottles filled with dilute alcohol and having tight glass covers through which the end of the thread is always projecting. (Fig. 74.) When the thread is used the assistant draws out and cuts off all that has been out of the solution. There should be a bottle for carbolized silk, a second for carbolized catgut, a third for silkworm gut.

The antiseptic solutions for use during the operation are kept in large bottles, *F*, *F*, *F*. They consist of bichloride of mercury solutions, of strengths varying from 1.500 to 1.10000; carbolic acid solutions varying from 1.20 to 1.50.

The towels are saturated in a solution of bichloride of mercury 1.500, folded and placed in a vessel, *j*.

The sponges are taken from the jars of carbolic acid solution, *N*, where they are kept prepared and ready for use, squeezed dry, and placed in a convenient vessel.

The gauze and absorbent cotton are laid in a basket, *M*, where they will be accessible for the dressings.

The irrigating solutions are put in large jars, *H*, *I*, *G*, placed on a shelf of such height as to give force to the current during the operation. In *H* is Thiersch solution—boracic and salicylic acid solutions; in *I* is bichloride of mercury solution 1.1000; in *G* is carbolic acid solution 1.30. The bichloride solution is in use in this operation, and to this jar a long tube is attached which terminates in a nozzle, having a valve worked by the finger of the assistant, who can thus perfectly control the jet. The solution is warm or hot. In private practice these solutions can be prepared at the bedside in pitchers, and poured from them upon the wound as required; or the common fountain syringe may be used. It is important that hot water should always be at hand, with which an antiseptic solution may be made, to be used in the wound to suppress oozing of blood.

Slop bowls, *D*, *E*, are arranged conveniently; some of which contain antiseptic solutions for the hands or sponges, and others are empty.

II. THE PREPARATION OF THE OPERATOR AND ASSISTANT.

The operator removes his coat and cuffs, and rolls his shirt-sleeves above the elbows. With hot water, soap, and brush, he thoroughly cleanses his hands and arms, and scrupulously cleans his nails. He then bathes his hands and arms in bichloride of mercury solution 1.500.

If compelled to make a vaginal or rectal examination before operating, preferably to be avoided, or to come into contact with ichorous infectious wounds, as carcinoma, erysipelas, etc., cleanse the hands with some material which aids, mechanically, in removing adherent secretions, for example, bran of almonds with the help of soap and water; dip the hands into a solution of (about one to a thousand) permanganate of potassium and remove the discoloration by pouring on a saturated solution of oxalic acid; in such cases all this is done before disinfecting with bichloride solution.[1]

Finally, he puts on the operating-gown, which fits closely at the wrist, with buttons to the cuffs, and is fastened about the neck by buttons, and about the waist by a belt. This gown may be made of muslin, should be washed every time it is used, and when ironed be kept in a box filled with the vapor of carbolic acid or other disinfectant.

---

[1] V. R. v. Hacker.

A linen duster answers equally well. No surgeon who fully appreciates the antiseptic method will operate without an aseptic covering of his ordinary clothes, which are, necessarily, more or less charged with dust and other forms of filth.

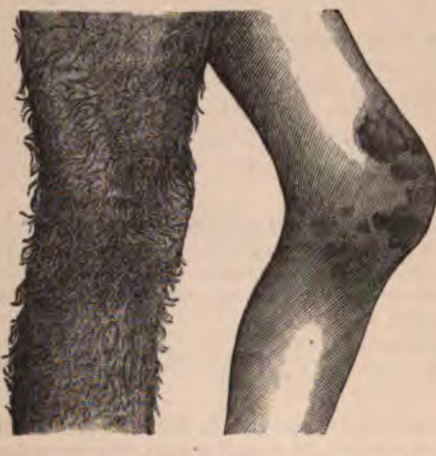
The assistants are four in number (2, 3. 4. 5). The first assistant (2), who, with the surgeon, manipulates the wound, should prepare himself in the same manner as the operator. The second (3) assistant attends to the instruments only, and must have clean hands, but he need not wear a gown. The operating apron will be sufficient. The third assistant (4) gives the anæsthetic, and the fourth assistant (5) irrigates the wound. They do not require to undergo any other preparation than that which secures general cleanliness. The two attendants (6, 7), who handle the sponges and other materials, should have their hands disinfected.

At an operation, each assistant is equally answerable with the operator; each deserves equal praise or blame in the success or failure of operation and treatment.[1]

III. THE PREPARATION OF THE TABLE AND PATIENT.

The operating table should have a hair mattress, covered with rubber cloth. In private practice a firm table should be selected; beds and sofas are no substitutes. Over the mattress should be laid the aseptic rubber sheet. The table should now be placed and arranged so as to secure the constant flow of the fluid of irrigation from the wound into the vessel underneath. To tilt an ordinary table properly a brick may be placed under each leg at the end or side of the table opposite the vessel which receives the fluid. Under the margin of the rubber sheet must be placed a second rubber sheet which is to be gathered into folds, and the lower end is placed into the vessel (Fig. 78).

Fig. 77.



Contrast of the limb prepared for the operation with its fellow.

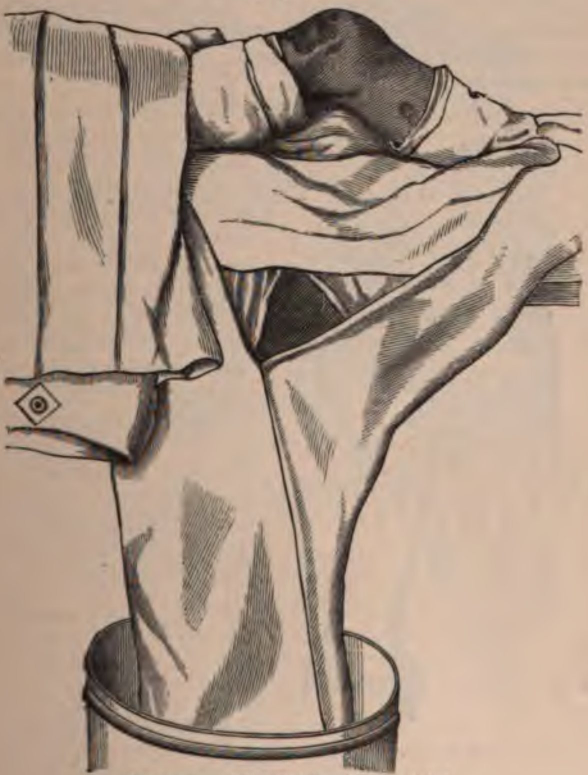
The cleansing and disinfection of the part to be operated upon follow. Whenever it can be done the patient should take a hot bath a little preceding the operation. In immediate preparation for the operation the limb must be thoroughly washed with hot water, soap, and brush from the toes to the hip; the limb should then be shaved with a sharp razor at least from the middle of the leg to the middle of the thigh. The importance of this precaution can scarcely be overestimated in any case, but its significance is strikingly apparent in the person who was the subject of the operation under review (Fig. 77). The whole limb should now be irrigated with the bichloride solution.

---

[1] T. Billroth.

The arrangement of the patient on the table must be such as to give the operator and assistant free access to the part operated upon, and at the same time to allow the full flow of the water of irrigation constantly into the receiving vessel. Towels wet with bichloride solution should be spread over the table and the parts in the vicinity of the wound, so that no disinfected surface shall be exposed, upon which an instrument or sponge may accidentally be laid. Towels wet with the solution should also be wrapped around the limb above and below the point of incision (Fig. 78).

Fig. 78.

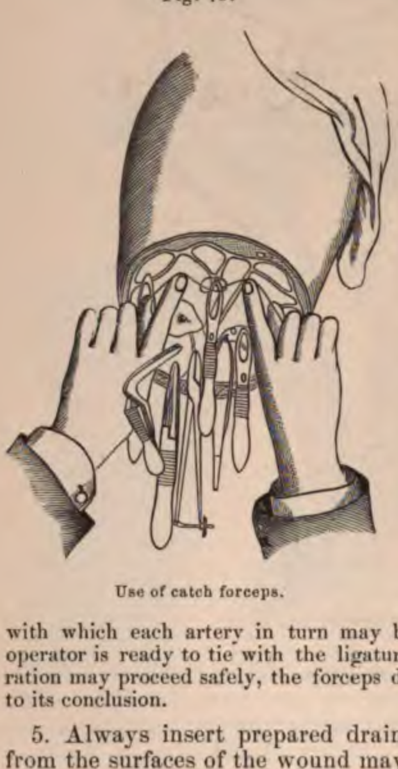


Leg arranged for excision of knee-joint.

IV. THE OPERATION.

The features of an antiseptic operation most important to be observed are briefly as follows: 1. Irrigation with the bichloride solution of the entire wound, and the parts immediately adjacent, should be continued, with short intervals, until the wound is closed by suture and dusted with iodoform. 2. The operator and first assistant alone should manipulate the wound, and they should occasionally place their hands in a solution of bichloride, especially if their hands are brought in contact with foul or decomposing materials, or if it is necessary to introduce the finger into a serous cavity; no bystander should ever be allowed to put his finger into the wound unless it is first thoroughly cleansed and disinfected. 3. Every instrument should be taken from the carbolic solution when about to be used, and should be immediately returned to it when not in use; sponges should be taken from the antiseptic solution, and, after being used, should be cleansed in the solution before they are returned to the assistant; if an instrument, or a sponge, fall upon the floor, they should not be used again during the operation, if they can be dispensed with; if used, the greatest care must be taken to have them first thoroughly cleansed and disinfected. 4. The closure of every bleeding vessel must be at once secured, both to avoid loss of blood and to prevent the accumulation of blood in the wound. The carbolized catgut ligature should be used for all small vessels; the silkworm gut, or the carbolized silk, or catgut prepared in chromic acid, should be selected for larger vessels. The ends should both be cut off near the knot, whichever ligature is employed. If oozing continues, irrigate with hot bichloride solution.

Fig. 79.

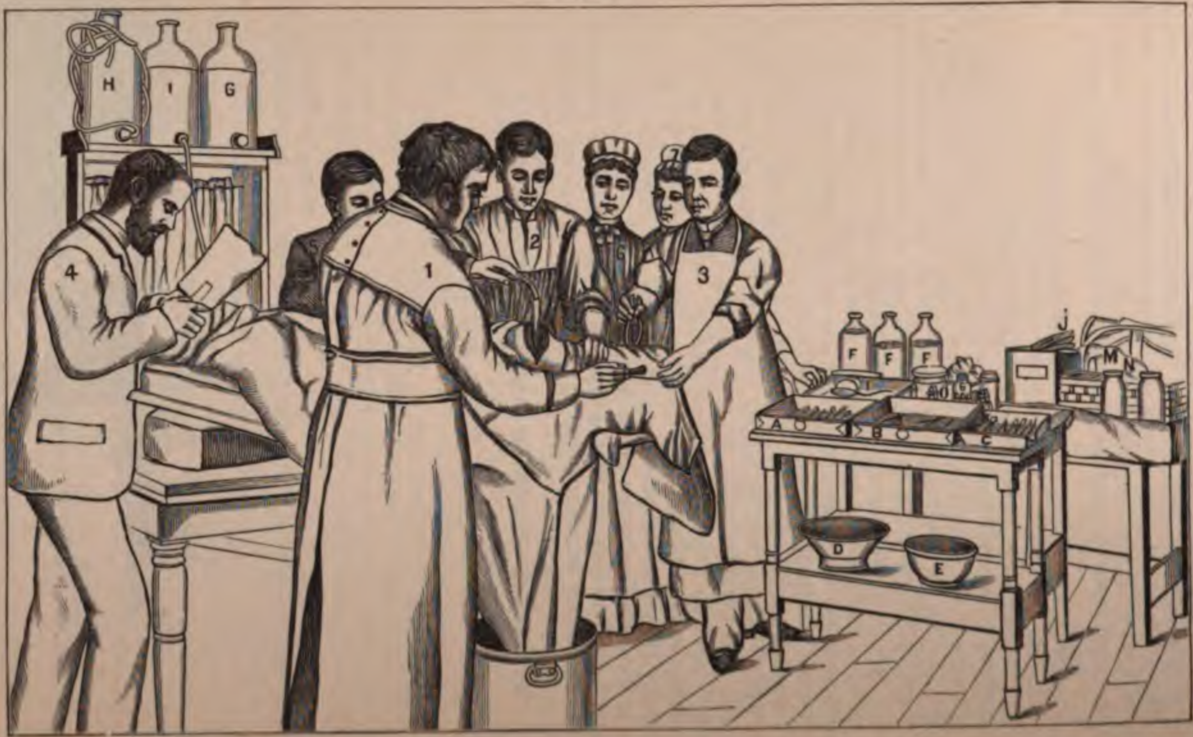


Use of catch forceps.

While it is very necessary to avoid the loss of blood during the operation it is not always convenient to stop the procedure to ligate each vessel divided. To arrest hemorrhage instantly, and still not interrupt the operation, it is necessary to provide a number of catch forceps with which each artery in turn may be seized and securely held until the operator is ready to tie with the ligature (Fig. 79). In this manner the operation may proceed safely, the forceps depending from the wound, oftentimes to its conclusion.

5. Always insert prepared drains, in order that the first outflow from the surfaces of the wound may at once escape; if there are deep recesses it may be necessary to introduce drains to the bottom of each. Even if the incision is not deep it may be useful to insert a

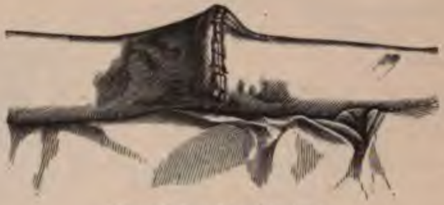
Fig. 80.



1, Operator; 2, 3, 4, 5, assistants; 6, 7, nurses; *A*, *B*, *C*, pans for instruments; *H*, *I*, *G*, antiseptic solutions for irrigation; *F*, *F*, *F*, solutions ready for use; *j*, antiseptic towels; *O*, antiseptic ligatures on reels in bottles; *M*, basket with absorbent cotton; *N*, jars of prepared sponges; *D*, *E*, washbasins.

few threads of catgut at dependent points in the line of the wound, and apply the sutures over them. In the final dressing and treatment of the wound new questions will arise which are considered in the following sections.

Fig. 81.



Wound closed and drained.

CHAPTER XII.

THE DETAILS OF ANTISEPTIC DRESSINGS OF WOUNDS.

Wounds are of various kinds, viz., subcutaneous, incised, lacerated, punctured, contused, poisoned. In treatment they may be classified as wounds to be closed and wounds to be left open; the former tend to primary union, and the latter to secondary union, or union by granulation. Although the morphological changes in the tissues are the same in both cases, the treatment by closing wounds, whether after an operation or an injury, is to be preferred whenever the conditions are favorable to primary union, as the wound heals more rapidly, with less inflammation, and gives more perfect results. Immediate union is the best imaginable process of healing.[1] Whatever may be the nature of the wound, therefore, every necessary effort should be made to reduce it to the condition of a wound to be closed. Subcutaneous and incised wounds should always be closed. Lacerated wounds may be so cleansed and have their ragged edges so cleanly cut away that they are in the condition of incised wounds, and should be closed. The wound having been cleansed with the bichloride solution, the nature of the dressing must be determined by the conditions and peculiarities of each individual wound.

I. THE ANTISEPTIC DRESSING OF CLOSED WOUNDS.

In applying immediate dressings be careful to make them as little irritating as possible to the young epithelium along the line of incisions.[2] If the wound has been well disinfected, properly closed, sufficiently drained, and compressed, it is of little consequence, in most cases, what sort of antiseptic dressing is used as direct covering, particularly in closed wounds.[3] Iodoform and carbolic acid dressings are

[1] Sir J. Paget. [2] W. W. Cheyne. [3] V. R. v. Hacker.

employed according to the preferences of the surgeon. Iodoform seems to possess many decided advantages over carbolic acid; it is less irritating to the wound, diminishes the discharge, and exerts a longer and more intense, though certainly slower, antiseptic action.[1]

Carbolic acid is still preferred by some surgeons of large experience, who regard iodoform as a less powerful antiseptic, and as having dangerous poisonous qualities. If carbolic acid dressings are applied it is necessary to prevent the irritation of the healing edge of the wound by the carbolic acid; a piece of protective is interposed between the gauze and the wound; this protective is cut a little larger than the wound, and it is well to cover the buttons, if used with it, also, in order to prevent the threads of the gauze becoming entangled in them. This protective need not extend over the orifice of the drainage tube, as its essential object is to protect the healing part from the irritation of the carbolic acid; this protective is also of use in preventing the dressing from sticking to the wound, and in preventing the formation of scabs, and the consequent possible retention of the discharge.[2]

If the wounds are quite superficial, they require no other dressing than iodoform, for healing readily takes place. In deeper wounds, after the closed wound has been dusted with iodoform, a pad of iodoform gauze is laid over the wound. The dressings which follow vary much in the practice of different surgeons, but the following method gives excellent results: Bandages are made of three or four folds of bichloride gauze, two or three yards long; they are first wrung out of bichloride solution, 1.1000, and then applied with repeated turns until the wound has three or more coverings; over this dressing is placed a layer of borated cotton; this is firmly bound by the dry bichloride gauze bandage. These dressings extend considerably beyond the wound. In wounds requiring fixation of the limb, as in excision of joints, the dressing is completed by two or three layers of gypsum bandage, which permits of the suspension of the part.

A very good method[3] of dressing is described as follows: After the operation has been completed, the wound drained and closed by sutures, and syringed out through the tubes with two and a half per cent. carbolic acid solution, and after the parts adjacent to the wound have been cleaned with carbolized sponges, the wound is covered with four to six thicknesses of absorbent iodoform gauze, which everywhere extends about a finger-breadth beyond the edges of the wound; then comes a layer of rumpled carbolic gauze, thicker or thinner according to the amount of discharge anticipated; then a layer of smooth carbolic gauze, or absorbent cotton, or cleansed gauze; and finally a piece of *Billroth battist* which has been dipped in a two and a half per cent. carbolic acid solution and wrung out, and which is large enough to cover the last layer completely. At the edges of the dressing strips of absorbent cotton or of cleansed gauze are laid, and pads of these are placed outside the impermeable material at those places upon which stronger pressure should be exerted. The dressing is made firm by means of common cheese-cloth bandages, over which, when a lasting compression is desired, several layers of buckram are laid.

II. WOUNDS WHICH ARE NOT TO BE CLOSED.

Iodoform[4] is of the greatest importance in this class of cases, since no other antiseptic dressing causes so little reaction, can be applied so simply, and requires so infrequent a change. Apply it as follows:—

---

[1] V. R. v. Hacker.

[2] W. W. Cheyne.

[3] Billroth's Clinic.

[4] V. R. v. Hacker, Billroth's Clinic.

Cavities,[1] after irrigation, should be packed with absorbent iodoform gauze; in irregular cavities, the lowest layer of gauze should consist of strips packed into the pockets and crevices of the wound; layers are then placed upon this till the cavity is filled to the level of the skin; over these are laid two to four thicknesses of iodoform gauze, which reach beyond the borders of the wound. The dressing is then completed in the same manner as closed wounds, except that compression should not be as great. This dressing may remain eight to fourteen days.

Deep or cavernous wounds,[1] which are fresh and clean, but which cannot be drained or closed, either because of too great tension of the skin, or because pressure sufficient to appose the deep parts is not practicable, require the same dressing as cavities. Such conditions are particularly prominent after operations on fungous growths, in the wounds involving canals lined with mucous membrane, in septic infected wounds and ulcers, and in those which are induced by specific diseases.

Infected wounds,[1] or wounded surfaces of a septic character, and gangrenous ulcers, require iodoform dressings as a rule. They cause both a cessation of decomposition and its consequences, and a cleaning of the wound with the formation of healthy granulations; in case of ulcerated carcinomata it is the best means of disinfecting the nauseating odor.

In specific ulcerations of lupus and tuberculosis it appears to have merely a purely local action on the superficial infiltrations and granulations.

In all these cases either iodoform powder is dusted on in a thin layer and iodoform gauze laid over that, or the latter alone is applied.

Granulating sinuses in the soft parts and in the bones[1] do not require that the whole wound should be left open, after scraping out the granulations, or after the partial resection of the bones, but if the soft parts have been extensively divided, for example, for closing a fistula, exposing diseased bone and the like, the wounds may be closed for the most part by sutures, after irrigation, provided only the large openings remain from which the discharges can flow, and through which the strips of iodoform gauze which were introduced can be removed. In such cases iodoform gauze is now used almost exclusively; or if one wishes more iodoform in the cavities, especially in cavities of bones, a thin layer of it is blown in. Since here iodoform remains in contact with the whole wound for a long time, often several weeks, the danger of iodoform intoxication must be carefully kept in mind, while with closed flesh wounds it hardly deserves consideration. With the pathological processes in question it is of special importance that all corners and recesses of the wound be in direct contact with the iodoform gauze, since, if such pockets are overlooked and not disinfected, the discharge may collect and decompose behind the gauze and give rise to local inflammatory manifestations which spread with unusual rapidity along opened sheaths of tendons, and to the well-known general results. Where bones are diseased in this way, all abnormal portions must be removed as far as possible. On this condition and only on this, as it appears, can healthy granulations form and local healing take place, together with an unusually abundant restoration of the destroyed portions of bone; without it relapses must be anticipated.

---

[1] V. R. v. Hacker, Billroth's Clinic.

Cold abscesses,[1] which arise merely from soft parts, or from bones which are accessible, heal perfectly under the iodoform dressing, after they have been opened and everything abnormal removed. Abscesses which arise from bone should be opened freely, and the carious cavity should, when it is practicable, be scraped with the scoop until the cavity is cleaned thoroughly, and then be dressed as before. Even if the dead bone is not accessible, it may be possible to wash out the carious cavity, and disinfect it with bichloride or carbolic solutions. By this treatment the system may be saved from further infection by absorption of purulent débris, and the cure greatly hastened.

It is still maintained, but unwisely, that abscess connected with bone which cannot be operated upon, especially abscesses from congestion, the rule yet holds of not undertaking any considerable operative interference, but of allowing spontaneous opening. The rule should be to evacuate the pus by puncture, and wash out the cavity with bichloride solution 1.5000. Or, inject iodoform suspended in a liquid-like glycerine.[1] In this latter treatment (which is entirely without danger) the cavity is not washed out with carbolic acid or the like, but as soon as no more pus can be removed through the canula of the trocar the antiseptic fluid is injected till the cavity is about half full, not fully distended; a dressing is then applied with moderate compression; to obtain healing it is often necessary to repeat the puncture and injection.

Wounds in the mouth[1] occupy a remarkable position, in that they have become almost free from danger under the use of iodoform, in the form of adhesive gauze. This is employed because it adheres firmly to the wound, and is thus prevented from being swallowed or from causing suffocation, and, on the other hand, because the iodoform is present in such large quantities, and clings so firmly to the wound, that it is not easily washed away by the secretions from the mucous membrane (page 83).

In these operations bleeding is arrested as perfectly as possible, partly by ligation, partly by compression, and the injection of ice water; two or more thicknesses of the adhesive gauze, cut into strips two or three finger breadths, are pressed upon the entire wounded surface, most exactly fitted into all angles and recesses, and, if necessary, fastened by several sutures. Parts to which gauze cannot be applied, viz., the throat and palate, are immediately and subsequently daily dusted with a thin layer of iodoform powder; drainage is employed only in operations on the floor of the mouth, in extirpation of the tongue, that is, only when an external communication has been formed by the operation. The adhesive gauze also allays any parenchymatous hemorrhage which may be present; the bloody fluid which at first oozes through is taken up with sponges, and grasped with forceps, which are applied quite firmly for several minutes.

This gauze, which, with the absorbed fluids, mats together in a tolerably firm mass, may and should remain quietly eight to fourteen days, till it falls out. There is no properly called after-treatment of such wounds, and the cleaning of the mouth, teeth, etc., which was formerly so scrupulously performed, has become of less importance.

---

[1] V. R. v. Hacker, Billroth's Clinic.

If the dressing is exactly carried out, the surfaces of the wound present not the least reaction, the discharge is very slight, and the patients feel perfectly well; they have no unpleasant odor from the mouth, and they suffer no pain; finally, by this treatment, through preventing decomposition of the discharge, the so-called deglutition pneumonia is prevented, which has been demonstrated to be a septic broncho-pneumonia. The upper layers alone are removed as soon as they are soiled by food, saliva, etc., or, if very much of the iodoform appears to have been washed out, they are dusted with iodoform powder, particularly if the gauze has become separated from the borders of the wound.

Wounds of the rectum, vagina, and urethra,[1] where the local relations render it more difficult to effect certain contact of all angles and surfaces with the iodoform gauze, absorbent iodoform gauze may be substituted; strips two to three finger breadths wide, and it may be even a half metre long, are loosely introduced into the cavity of the wound till it is everywhere covered; the ends of the strips are left out, and to soak up the fluid, cleansed gauze or absorbent cotton is added, and the whole covered with impermeable material. Drainage tubes sometimes used are put in place at first, and brought out by the side of the gauze; they are removed after six or eight days, till which time, if there is no fever, it is usual to allow the gauze to remain. Instead of the roller-bandages, towels, in the form of a T-bandage, are preferably used; the superimposed gauze or cotton is of course changed daily in cases of wounds in the vagina, rectum, urethra, etc.; the wetting of the iodoform gauze with urine and the like does not disturb the antiseptic course of the case. At the end of a week, when the dressing is first changed, the wound has contracted considerably; the gauze, which is saturated with discharge, but which never has an ill smell, is replaced by fresh strips loosely introduced, which, in their turn, may remain a week; if the wound granulates, ointment on linen or on tampons is used.

III. CHANGING THE DRESSING.[1]

Although the dressing may remain fourteen days or longer without injury to the wound, even when blood and discharge have soaked through to the outside (a very important consideration for army surgery), yet it is better to change it every eight or ten days, since otherwise the gauze which has been saturated with discharge, and then dried, may confine the perspiration, and by that means cause eczema. After large operations, it is now and then desirable to change the dressing on the evening of the same day or on the following day, because blood has soaked through; if the amount of discharge, which has soaked through is considerable, it is sufficient, for the sake of keeping the bed clean, to cover the wet places with new pieces (carbolic gauze, absorbent cotton, impermeable material), and perhaps on the following day to renew the dressing fully; if the discharge has not soaked through, the dressing may remain a week or longer. Very large wounds can heal perfectly in three or four weeks, the dressing being changed two or three times; in most cases the wound is dressed on the sixth or eighth day for the sake of removing the tubes and sutures; if healing by first intention has been imperfect, the tubes must, of course, remain longer, where suppuration has occurred; they are then gradually shortened and finally removed. If the dressing of partially open wounds must be changed because of unusually abundant discharge, the gauze adherent to the wound is left, and only the external layers, the carbolic gauze, or cotton, are changed. In cases of complicated fracture, where an infrequent change of dressing and rest of the injured part are of the greatest importance for the sake of callus formation, the dressing may remain two weeks, or even three weeks if the course of the case shows no reaction; but then the openings occupied by the drainage tubes take longer time to close, and even small scars are left. It is necessary to change the dressing if the temperature is high (102.2° F., or over), especially if a rigor occurs; desirable, for the sake of greater safety, if blood soaks through profusely; when fever appears retention of secretion is first to be thought of, then death of tissue from too strong compression, too great tension of the sutures, etc.; when the dressing is changed the perviousness of the tubes must be tested by taking them out and syringing through them if necessary; if the tension of the sutures is too great, it must be lessened by cutting them. If the febrile symptoms do not yield to this, if the discharge increases and becomes more purulent or ill-smelling, a very rare occurrence however, the dressing must be renewed every day or every second day, and because of the danger of intoxication but little iodoform gauze must be applied. In such cases the wound is exceptionally washed out with a strong carbolic acid solution (five per cent.), or with chloride of zinc solution (1.500), though usually when the dressing is changed the wound is not washed out, nor should it be pressed.

---

[1] V. R. v. Hacker, Billroth's Clinic.

Patients should not be disturbed by unnecessary syringing[1] of the wounds and of the sinuses from bones or abscesses; the retention of a certain amount of laudable pus causes no harm. Syringing of abscess sinuses injures more than benefits. They should be syringed only so long as the pus smells somewhat badly. We cannot prevent such an occurrence even by daily syringing.

Only when the gauze adheres very strongly should it be moistened with the irrigator to remove it more readily. If the washing out does not succeed in causing an immediate fall of temperature and a disappearance of the general symptoms, loss of appetite, weakness, etc., it is a proof that the disinfection of the wound has failed, and it becomes necessary to loosen the sutures, and to pack the wound, thus opened, directly with iodoform gauze, for which acetate of aluminium or chloride of potassium must be substituted if a frequent change of dressing is necessary. When the wound is perfectly cleansed, in order to hasten somewhat the healing, one can subsequently bring about a partial closure or approximation of the borders of the wound by means of secondary sutures; for this purpose strong silver wire is most suitable, or one may apply strips of iodoform plaster or common adhesive plaster; in general the iodoform gauze remains till into the second or third week—until the wound has granulated well. It is not expedient to use it longer, because the exuberant granulations grow into the meshes of the gauze, which cannot then be removed without hemorrhage. Granulating wounds are dressed with ointment, zinc, or boracic acid ointment; if the granulations are very lax or too exuberant, nitrate of silver ointment and touching with lunar caustic are appropriate.

---

[1] T. Billroth.

IV. PRECAUTIONS IN THE USE OF ANTISEPTIC AGENTS.

The antiseptic agents which require especial care in their use, on account of their poisonous qualities, are bichloride of mercury, iodoform, and carbolic acid.

Bichloride of mercury is the most powerful poison used in antiseptic practice, and yet it is quite harmless when properly employed as an antiseptic. This is due to the fact that bichloride is a germicide in a solution, so weak as not to endanger its use upon broken surfaces, provided it is not retained in contact so long as to undergo absorption in considerable quantities. A solution of 1 in 40,000 is efficient. The rule in employing it should be to use the stronger solution, viz., 1.500 only on the skin for cleansing. In open wounds, during an operation, where the solution flows rapidly away, the strength may be 1 in 1000 or 2000. In cavities where the solution may be retained the solution should be 1 in 5000 to 10,000, and it is well, finally, to irrigate the entire cavity and its recesses, before closing it, with simple warm water, in order that no collection of the solution may remain. If the wound is to be subjected to the continued action of the bichloride, as in a bath, the strength should be no greater than 1 in 100,000. The symptoms of poisoning by the bichloride take the form chiefly of gastro-intestinal irritation, and are relieved by the usual remedies for that affection.

Iodoform[1] should be used with proper caution, for although many of the cases described, especially those ascribed to fatal iodoform intoxication, may have been due to acute sepsis, still there is no doubt that iodoform can by long-continued action give rise to a large number of symptoms of intoxication; as proof of absorption iodine can be demonstrated in the urine immediately after its use. In lesser degrees of poisoning, the symptoms are general malaise, loss of appetite, dulness, taste and smell of iodoform, then headache, vomiting, etc., that is, as a whole, gastric symptoms; in higher degrees, disturbances of cerebral functions, either under the form of intellectual disturbances or of a meningitis; these manifestations may be succeeded by coma and death. The method of our present dressing takes this danger into consideration. No large amount of iodoform in substance is introduced into the wound itself. In general, iodoform in powder is only used on wounds in the mouth, in large cavities in bones after the removal of the contents, and on septic infected wounds and ulcers, as well as on ichorous carcinomata, and in these cases it is only blown on in a very thin layer; in other cases, both of closed wounds and of cavities, nothing but iodoform gauze is employed, so that only small amounts of iodoform come in contact with the wound itself; this gauze is allowed to remain a long time, since the removal of the dressing is proportionately infrequent. It becomes necessary to change the dressing frequently if the discharge is abundant, etc.; very little gauze is used (perhaps two thicknesses for a direct covering of the wound), or another dressing (carbolic acid gauze, acetate of aluminium, chloride of potassium), is substituted for the iodoform. With wounds in the mouth it is of special importance that the gauze be seldom changed, since from here intoxication may readily arise; the end is easily and perfectly attained by means of the adhesive gauze.

---

[1] V. R. v. Hacker, Billroth's Clinic.

Carbolic acid,[1] in the concentrated form, cauterizes; even in the dilutions we commonly use, it exercises a deadly irritation on the skin and wounds; its absorption can cause at times severe, even fatal, intoxication, particularly in weak, anæmic children. Often the only symptom of the absorption of carbolic acid is a light green, olive green to black, discoloration of urine. The headache, loss of appetite, and vomiting, which occur in light cases, are accompanied in severe cases by bloody diarrhœa and symptoms of collapse, fall of temperature, sluggishness, or absence of pupil reaction, cold sweat, superficial respiration, and finally even unconsciousness and death. Although, as a rule, no manifestations of poisoning appear from the use of so weak solutions as we employ, still one must always consider that with children and debilitated patients too much carbolic acid must not be used, and that too much must not be left behind in large cavernous wounds, particularly when they are near that very absorbent membrane, the peritoneum, nor during operations in which the abdominal cavity has been opened. For this reason the sponges used in laparotomy are firmly wrung out, and the wound cavity carefully dried with them; and only a one per cent. carbolic acid solution is used for irrigating cavities lined with mucous membrane and wounds involving such cavities; besides the prophylactic measures, sulphate of sodium (Glauber's salts)[2] is the only direct antidote that deserves special mention; this changes carbolic acid into innocuous phenyl, which is then excreted by the kidneys; it may be administered by the mouth as well as by the rectum; yet in the most dangerous cases it has often been given without success, since it acts slowly.

V. THE OPEN TREATMENT OF WOUNDS.

The open method of treating wounds is to be adopted only when antiseptic agents cannot be obtained. This process involves the separation of the dead particles and the formation of granulation tissue.

Place the part in an easy position, support it by a pillow of oakum, cover with gauze, and protect from the contact of the bedclothes with a cradle; use no suture except at the angle of the wound, nor adhesive plasters, oiled silk, compress, or bandage; wash the wound at frequent intervals with carbolized water by means of a douche, and pour over it balsam of Peru; receive the drainage in a disinfected vessel, and remove it frequently; when suppuration has nearly subsided approximate and mould the flaps with adhesive plaster.

---

[1] V. R. v. Hacker, Billroth's Clinic.

[2] Bauman.

VI. THE HOT WATER TREATMENT OF WOUNDS.[1]

This method has a very limited usefulness, being adapted to wounds much lacerated or in gangrenous tissues, and liable to profuse suppuration; submersion of such wounds diminishes fever, limits the area of acute inflammation, restrains and arrests erysipelas and gangrene, and prevents purulent infiltration, septicæmia, and pyæmia; it is not necessary to preserve an absolutely uniform temperature of the water, but it should always feel warm to the patient, and this temperature is found to be from 95° F. to 100° F.; in cases of incipient or progressive gangrene, the temperature may be raised to 110° F. Antiseptics may be added, as bichloride of mercury 1.50,000, or carbolic acid 1.100. In case of a recent wound, where secondary hemorrhage is at all liable to occur, dress the limb for a few hours with either warm or cold fomentations, but apply neither sutures, adhesive plasters, nor bandages. At the expiration of this time commence either the bath or the warm-water fomentations, and employ them thereafter systematically; the patient is at liberty at any time to lift the limb from the bath, and he generally does this pretty often, to see how it is progressing.

Warm-water fomentations are second in value to submersion, in the prevention and cure of inflammation, and are to be reserved for those examples in which submersion, for one or another reason, cannot properly be employed. Fomentations should be employed after about the tenth day in all those cases in which submersion is at first practised; when the patient is weary of the confinement to the bath, the limb is taken out and fomented during the night. In using the fomentations, envelop the wound and limb in several folds of sheet lint or soft old muslin, saturated with warm water, the whole being inclosed in oiled silk or vulcanized rubber; this is to be changed about once in four or six hours. The lower extremities can only be completely and permanently submerged to a point three or four inches below the knee, and the upper extremities to a point a few inches above the elbow, consequently submersion is limited to those portions of the extremities which are below the points mentioned. A vessel, in which the part can be immersed, may be obtained in any household.

CHAPTER XIII.

THE PROGRESS OF THE REPAIR OF WOUNDS.

After an operation an entirely new case begins, a case not of disease, but of injury.[2] The immediate effects of the operation are seen in a variation of temperature; at first it sinks, but not below the normal; then it ascends, either slowly or suddenly, for a few hours; in some cases there are intercurrent falls of temperature, usually followed by renewed elevation.[3] The principal factors in reducing bodily heat immediately after operations are loss of blood, the narcosis of the anæsthetic, the pain of the wound, and prolonged exposure of the body.[1] The intensity of this shock commonly determines the time, and, in a less degree, the intensity of the reaction which in the ordinary course immediately follows; in some cases, even after severe wounds and much depression, the reaction does not go beyond the recovery of the natural standard of the heart's action, and of other functions; there are neither fever nor other signs of general disorder, and repair may make unhindered progress.[2] In every form of wound there is a new histological condition, namely, a rapid multiplication of cells, and it is upon the determination of their relations and changes that the future condition of the wound depends; if they are removed from the tissue, resolution, or a return to the natural state, will result; if they undergo fatty degeneration, pus will be formed; and if they become organized, new tissue will be incorporated with the old. Repair may therefore proceed to its termination with but little more excitement than attends physiological processes, or complications may arise which modify its progress and its completion. When the process is normal there is an orderly series of changes noticeable at every stage, and when complications occur there are marked and characteristic deviations.

---

[1] F. H. Hamilton. [2] Sir J. Paget. [3] E. Wagner.

I. INDICATIONS AS TO THE PROGRESS OF REPAIR.

It is of the first importance to be able to determine at all times the nature of the changes which are taking place in the injured part, whether reparative or destructive. The most reliable indications of these changes are found in the appearance of the wound, the degree of bodily temperature or fever, and the nature of the pulse. Whenever there is any considerable deviation from the normal healing of the part, these features of every case are notably affected, sometimes so much in advance as to give the surgeon timely warning of approaching danger and enable him to protect the patient from serious consequences. The state of the wound, the fever, and the pulse, therefore, should be accurately recorded at least twice daily; carefully observed, they form a group of most reliable indices of the hourly progress of the case. The phenomena which they respectively present are so interdependent that they must be regarded as a single series of symptoms having a common cause. Every change should therefore be duly noted, and its significance appreciated.

The wound is the seat of those local changes, reparative or destructive, which occur in the progress of repair, whether it pursue a normal or abnormal course; these changes are largely influenced by the immediate conditions which surround the wound.

The fever, denoted by bodily temperature, is, as a rule, the measure of the disturbance of the nervous and vascular system; if it occur during the first twenty-four hours it is probably due to the operation, but if it appear later it is due to tension, or to blood poisoning by the absorption of dead and septic matters into the circulation.[1] Any sudden increase of temperature is always suspicious of some important change in the wound. The variations of fever may announce conditions in the reparative action, favorable or unfavorable,

[1] T. Billroth.

[2] Sir J. Paget.

many hours before they are indicated by local appearances or symptoms.[1]

The pulse, though much influenced by mental states and other conditions foreign to the wound, is still a reliable index of the degree of arterial tension, or resistance of the organism to the depression and exhaustion which the irritants derived from the wound induce.

II. THE CONDITIONS OF NORMAL REPAIR.

The process of repair may proceed in a normal manner under apparently very different conditions, viz., in closed and open wounds. In the former, union may be immediate, or by primary adhesion, and in the latter it may be by granulations or of granulations.[2] Different as these processes appear at first glance, the essential changes in the tissues are in both cases the same.[3] Passing over the familiar textural changes by which union of wounds is effected, the question of greatest practical interest is as to the conditions most favorable to normal repair in these two classes of wounds, and the methods by which they are secured.

It may be stated as an accepted principle that the best imaginable process of healing requires, as one essential condition, that there shall be an absence of all inflammation.[2] This mode of repair is truly physiological, and closely resembles the normal growth of tissues. But the repair is still normal when, in certain wounds, the inflammation is limited in its effects. In union by adhesion an inflammatory process ensues which may be regarded as necessary for the production of new reparative material, but it should not go beyond this, for its continuance is a hindrance to that organization of the reparative material essential to complete adhesion; so in healing by granulation, if inflammation is present, and the lowest degree is best, it is only for the production of the first material for granulation.[2]

But the course of normal repair is liable to various interruptions and complications. A wounded part appears to be a structure in which morbid conditions of the blood are peculiarly prone to manifest or localize themselves; if an exanthem, as measles, appear after an operation, the thickest of the eruption will be at and about the wound; the general malady of erysipelas may have its local expression chiefly or only at the wound, and scrofula or syphilis, previously latent in the system, may find at a wound a place more fit for their manifestation than any sound structure.[2]

III. THE OCCURRENCE OF HEMORRHAGES.

Repair may be interrupted at any stage by hemorrhage; the wound and tissues are thus filled with coagula, which separate the flaps, and, in softening, give rise to pus and very irritating matters.

Intermediary hemorrhage may occur at any time subsequent to reaction, and before suppuration is established, namely, between the first and sixth days. It is the result of returning circulation, and if moderate, from small vessels; it demands no special attention, for in a few hours the progress of inflammation will prevent the slight oozings of blood; if the bleeding is excessive, or proceeds from larger vessels, it must be promptly arrested; if the limb is in a depending position, or a bandage causes ligation, change of position, and dressings, cold, or pressure may answer; if these measures do not promptly succeed, remove the dressings, open the wound, wipe away the clots, and secure the vessel with a ligature.

---

[1] T. P. Pick. [2] Sir J. Paget. [3] T. Billroth.

Secondary hemorrhage[1] occurs during the period of suppuration, or between the sixth and twentieth days, and especially about the fourteenth day; it may be sudden and severe, but more often it is slight at first. It may be due to many causes, the chief of which are sloughing of a contused artery, or of an artery contained in a slough; penetration of an artery by ulceration; failure to form a firm clot in its calibre; breaking down of the adhesions formed at the mouth of the vessel; imperfect closure of the breaches in wounded vessels; an unsealed end of the distal portion of a severed artery; impoverished blood from diathetic disorders, as scurvy, syphilis. If the bleeding is from a vein or small arteries, arrest it temporarily by pressure with the finger, and permanently with a roller bandage; if the bleeding is from a larger vessel, apply a bandage evenly from the extremity of the limb some distance above the wound, with a compress at the wound, and a second laid along the course of the artery on the proximal side; if there is oozing from small vessels in deep cavities, resort to hæmostatics, as persulphate or perchloride of iron; if the bleeding is parenchymatous, apply the actual cautery where the parts are in a sloughing condition and arteries will not maintain the ligature, the cautery being so thoroughly applied as to destroy the entire slough and seal up the bleeding vessels; by ligature, if there is a wounded vessel at the seat of injury, tie both cut extremities; when compression has not proved effectual, ligate the trunk of the artery; if the limb or life is seriously threatened by delay or the use of other measures, resort to amputation of the limb.

Parenchymatous hemorrhage[1] usually occurs as an oozing, from the granulating or ulcerating surface of the wound, of blood neither venous nor arterial in appearance, but resembling what flows from dilated capillaries; it may also occur in the primary, intermediary, and secondary periods in the history of the wounds; in the primary period it is liable to attend operation-wounds made in inflamed tissues, the capillary bloodvessels being still paralyzed by the inflammatory process, and unable to contract and close the open vessel; in the intermediary period it occurs when the dilated capillaries are so feebly and imperfectly closed that in the vascular excitement attending reaction, the blood is forced out of the vessels into the wound; in the secondary period it is associated with pyæmia, and is caused by the obstruction of the veins of the parts with coagula.[2] The treatment of capillary hemorrhage after an operation must be with the application of a strong solution of persulphate or perchloride of iron directly to the bleeding surface, by laying on lint saturated with the styptic solution. If the seat of hemorrhage is a stump, the dressings must be removed and the wound freely opened. If styptics are not present, apply water of the temperature of 160° F. by means of a sponge; if this fail, cauterize with the hot iron. Hemorrhage in the secondary period from thrombosis is almost necessarily fatal, owing to the constitutional condition of the patient, and is to be met with styptics and pressure, and, if these fail, by ligature of the main artery if the patient is very low with pyæmia, or amputation if he is not too much reduced and pyæmia has not appeared.

---

[1] J. A. Lidell.

[2] F. Stromeyer.

IV. REPAIR INTERRUPTED BY GANGRENE.

When there is complete loss of vitality of the tissues through chemical or mechanical action, death of the parts follows, as in complete arrest of the circulation by compression, or other mechanical cause.[1]

Traumatic gangrene may be one of the earliest complications of the wound, the margins rapidly becoming cold and assuming a shrunken, dark, or purplish appearance, the extent depending upon the amount of tissue involved. It may be caused by direct violence, the tissues being devitalized, as in crushing injuries in which the amputation has been performed too near the seat of injury; or by constriction or occlusion of the main artery or vein, or of the neighboring vessels also, as after shot injuries, which either sever the arteries or give rise to large inflammatory effusions that occlude the collateral channels;[2] or, finally, by improperly applied dressings which too much constrict the parts or the vessels. As repair cannot proceed until the dead tissues are removed, the treatment should aim to prevent extension of the gangrene, and secure an early separation of the dead structures. The first indication is met by removing every source of irritation, and promoting the circulation in the part, and the second by excision. Where the gangrene is limited to the integument, all the dead tissue should be removed with the knife or scissors, as far as practicable, and the surface dressed with iodoform, which must be retained several days without change. If the gangrene involve the limb, as after ligature of the artery, gunshot, or tight bandaging, amputation, promptly performed, is the sole remedy, the point at which it should be practised depending upon the place of vascular injury.[2]

Phagedæna[3] may occur as a round black slough, with thickened border, or in the spreading form in which the wound opens with an irregular edge, and a foul, sloughy surface; its origin is obscure, and though possibly due to carelessness in the use of materials in dressing wounds, hospital influences have not been proved to originate it, as in the case of hospital gangrene; little or no constitutional fever accompanies it, and it involves very little danger to life; in some cases the pain in the wound is very great, requiring large opiates, and again the sloughing spreads with but little pain; occasionally the pain ceases, and the temperature due to the traumatic fever falls to 98° F. twenty-four hours before the slough appears. The treatment consists in securing a healthy surface by removing the diseased tissues with the cautery, or caustics, and the application of iodoform dressings.

---

[1] T. Billroth. [2] J. A. Lidell. [3] T. Holmes.

Hospital gangrene appears as a pulpous or ulcerous change in the granulations of a wound, of a yellowish-gray color, and extends to the surrounding skin.[1] It is a contagious disease, and occurs in the wards of hospitals, overcrowded and badly ventilated and cleansed; it may attack any wound, at any stage of repair, as the result of inoculation, or may be generated where to all appearances there is no abrasion of even the cuticle; its first appearance in an open wound is marked by blackish-gray points, and suspension of the healthy secretion, the discharge becoming thin and sanious; the edges are livid, raised, and everted, while a broad erysipelatous area extends in the skin, and the whole part exhales an offensive and penetrating odor; in six to twenty-four hours the grayish spots multiply and completely cover the part with a pulpy, tenacious mass, through which ichorous fluid is discharged, the slough burrowing under the integuments, particularly in the direction of the cellular planes; circular sloughs separate, but not deeply, giving a ragged appearance to the wound. The general symptoms are pain in the part, often excruciating; fever is not uniform; when present is typhoid.[2] In the treatment, the patient should be isolated, in a well-aired room, and have nutritious diet; opium should be given to allay pain, and tonics, quinine and iron, to improve the general condition. The local treatment, which is of the greatest importance, should be first directed to thorough cleansing and disinfection of the wound, and for this purpose bromine gives the best results; cleanse the affected part of all secretions, by washing with soaped water, remove with forceps and scissors all sloughy tissue, free the surface of all moisture by swabbing with lint and penetrating every recess, then apply bromide thoroughly; or sprinkle the surface with iodoform and pack every recess with iodoform gauze in strips.

V. INFLAMMATION COMPLICATING WOUNDS.

Those forms of inflammation which, by their destructive local effects, seriously interfere with repair, depend upon septic processes in the wound; the degree of development of these inflammations, or whether they are developed at all, depends upon the nature of the wound, the mode of dressing, the state of the atmosphere in which the patient is, the mechanical factors which favor the entrance of putrid substances into the tissues and the blood, and the quality of such putrid substances.[3]

Erythema appears as a blush around the wound, without fever or other symptom; there is slight tumefaction from turgescence of the capillaries, and the migration of leucocytes into the cutis and subcutaneous areolar tissue.[4] It is due to the action of irritants upon the specially sensitive papillary body, which reacts to the stimulus by hyperæmia.[5] It may terminate in resolution or inflammation. The treatment indicated is cleanliness and cold.

---

[1] T. Billroth.
[2] F. H. Hamilton, Jr.; J. Jones.
[3] E. Wagner.
[4] R. Volkman.
[5] E. Rindfleisch.

Erysipelas has a toxic origin; the wound may be poisoned at the time of the operation and erysipelas follow within a few hours, or blood mixed with decomposing secretions may excite the disease on the second or third day; or the poison may reach the wound through the air, sponges, and dressings at any time; the inflammation is generally limited to the cutis, and spreads through the lymphatic network.[1] Organisms, as bacteria, are found in the vessels of the inflamed skin, the number varying with the progress and severity of the disease,[2] but their relation to its origin is undetermined. The attack is often ushered in by a chill, followed by a fever; the edges of the wound become red and swollen, and this area extends with burning, stinging pains; the temperature rapidly rises to 104 F. or 106 F., and fluctuates but slightly until the inflammation subsides; the disease continues a variable time, but rarely exceeds ten days. The indications are to cleanse and disinfect the wound and adjacent parts with carbolized water, 1 to 20; inject a stronger solution, 1 to 10, or bichloride solution 1 to 10,000, cautiously, into the inflamed connective tissue; apply iodoform dressings to the surface,[3] secure perfect drainage of the wound; correct any existing derangement of the digestive organs; administer tr. ferri muriat. in full doses, and add quinine, stimulants, and nutritious food, as the case may require.

Lymphangitis may occur in any wound, and is due to a poison passing through the lymphatic vessels; this poison may be decomposed secretions from the wound, or putrid matters; it appears as fine red striæ, running longitudinally from the wound towards the swollen and sensitive glands; the limb is painful on motion; there is fever, loss of appetite, and general depression; the inflammation may terminate in resolution, or in the formation of abscess at some point.[2] The treatment should be to cleanse the wound of all irritating matters, and elevate the inflamed part.[4] If there is gastric derangement, give an active purgative, make application of soothing lotions to the inflamed vessels, and poultices to the glands; nitrate of silver applied to the track of the vessels, and inunctions of mercurial ointment, are often useful, but the latter may induce salivation;[5] wadding or moist warmth, applied to the limb, to maintain an elevated regular temperature is important;[1] if the inflammation becomes diffused, abscesses will form, which must be early opened.

Septic inflammation arises from putrid matters on wounds which diffuse rapidly in the meshes of the cellular tissues, and cause, on the second, third, or fourth day, those forms of inflammation characterized by rapid extension and decomposition of the inflammatory product; subsequently, when there is already suppuration, and the wound is open, mechanical irritation, foreign bodies, or infection of the wound may induce phlegmonous suppuration around the wound.[6] The treatment should be the removal of every source of irritation, thorough cleansing of the wound, and disinfection of the entire area of inflammatory excitement with strong carbolic or bichloride solutions and iodoform dressings.

---

[1] T. Billroth.
[2] Lukomsky; W. Moxon.
[3] E. Rindfleisch.
[4] T. Bryant.
[5] T. Holmes.
[6] Sir J. Paget.

Acute inflammation[1] may appear at any stage of the healing, but unless excited by local irritation, its occurrence becomes less probable as the time increases; it is most liable to attack wounds of those tissues in which, from ordinary causes or as if spontaneously, inflammation is most frequent, namely, the joints and the serous membranes. It may be of a sthenic or asthenic type; the former is attended with more swelling, pain, and redness, and a higher grade of fever; but the effects on the healing process are the same, viz., suspension of repair, and degeneration of the new-formed structures; granulations become œdematous or shrunken, thin serous discharge takes the place of pus, and new cuticle is cast off. The treatment of sthenic inflammation, when perilous to the part or to life, should be actively antiphlogistic, namely, bleeding, local, or general, according to the condition of the patient and the seat of the wound; moist, soft applications to the part, with ice or cold irrigation; in the asthenic form, the remedies must be of an opposite kind, namely, wine and tonics internally, and hot poultices to maintain the heat of the part, with free use of disinfectant solutions.

Chronic inflammation[1] not unfrequently occurs in healing wounds, especially amputation and excision wounds, and is chiefly a local fault; the granulations become pale, firm, œdematous; the adjacent structures feel lumpy, heavy, firm, and consolidated, as if filled with half-organized matter; it destroys the natural mobility of parts, and is associated with tardy and insecure healing; if the healing is not far advanced, it may be dangerous through the usually coincident softening and degeneration of the proper textures of the part and of the arteries. The treatment is local stimulants, friction, and pressure. It may be necessary to scrape away the granulation tissues and apply stimulating disinfectants, as carbolic solutions, followed by balsam of Peru.

VI. FORMS OF FEVER WHICH MAY OCCUR.

The fevers which complicate operation wounds may have their origin in local changes, but their destructive effects appear chiefly in the systemic circulation. Frequently as fever is met with, it is not an essential accompaniment of wounds as such, but is always an accidental affection; it may be developed at any time from the reception of the injury to the healing of the wound. Its presence must therefore be regarded as a complication indicating changes other than those which are required in the simple act of healing. As a rule, in those cases in which fever appears, it begins on the second day and continues until the seventh; if an operated patient is free from fever at the expiration of the fourth day, he will probably remain without fever.[2] As the etiology of these fevers is not well understood, the terms used to designate them are vague and unsatisfactory; but as they are familiar it is desirable to employ them, with such restricted and well-defined meaning as will give them the greatest practical significance. The following classification of the so-called fevers which may occur after operation wounds is more nearly in accordance with the present accepted views of their causes and pathology.

---

[1] Sir J. Paget.

[2] E. Wagner.

Traumatic fever, which ordinarily includes the febrile affections following injuries and operations,[1] may be limited to that increase of bodily temperature due to the immediate effects of the operation, or traumatism. The shock of the operation is often followed by excessive reaction, with elevation of temperature not unlike inflammatory fever. The pulse and respiration become more rapid, the former in a greater ratio than the latter, particularly when there has been much loss of blood; the pulse is also generally fuller and harder; the skin is flushed and feels hot; thirst is increased and appetite lessened; the amount of urine is diminished; the bowels are inactive; the tongue usually white-coated, large, and moist; the sleep short and often disturbed; the temperature is variable, and bears no definite proportion to the severity of the injury, or, so far as is yet known, to any of the events connected with it; not rarely it subsides within twenty-four hours.[2] The treatment should be preventive, by guarding against its causes, namely, loss of blood, narcosis, exposure to cold and shock.

Inflammatory fever appears with those changes in the wound recognized as peculiar to inflammation. The absorption of particles of dead tissue may, even at this early period, be one element in causing a rise of bodily heat.[1] The presence, intensity, and duration of this fever depend upon the presence, intensity, and duration of the inflammatory process; it may, therefore, be absent, or slight, or severe. When present, the patient feels hot, or alternately hot and chilly; his skin, lips, and mouth become dry; the urine is less and less in quantity, and of higher color; the pulse is quickened, tongue dry and furred; there is thirst, restlessness, intolerance of disturbance, face flushed and anxious, troubled sleep, or delirium. It lasts from one to seven days, the highest temperature being reached upon the first or second day, and seldom from the third to the fifth days. Relieve the wound of tension by removing dressings, sutures, or collections of fluid which cause undue irritation; cleanse the wound with bichloride solutions 1–1000, and apply iodoform dressings; change the dressing and renew the cleansing if fever continues.

Septic fever, septicæmia, is a constitutional, generally acute disease, due to the absorption of various putrid substances into the blood,[1] such as the putrid and toxic products of decomposing pus and blood, and the exudative detritus of gangrenous marrow.[3] It occurs in wounds not aseptically treated, or in deep wounds, and those involving bone, in the course of which decomposition of the extravasated blood, stagnant pus, and gangrenous tissues occur, and cannot be, or are not, thoroughly disinfected by antiseptic solutions. These fluids are highly charged with organic germs, which seem to have a causative relation to their destructive effects.

The chief factors in the production of the putrescent fluids of wounds are: (1) the formation upon the wound of putrid substances, or septic poisons; (2) debilitating influences, as fatigue, loss of sleep, alcoholic habits, exposure to cold prolonged several hours after injury; (3) atmospheric agencies created by the crowding of the sick, or the presence of putrid emanations.[3] The poisons, or miasma, which vitiate the air must be regarded as the dust-like dried constituents of pus, and possibly also accompanying minute, living, and active organisms, which are suspended in the air of badly-ventilated sick-rooms, where patients are carelessly attended and there is deficient cleanliness.[1] These causes may act singly or together, but as soon as the blood has become altered by its infection, and the fever has declared itself, the suppuration, instead of remaining local, becomes generalized.[2] The pathological changes are not characteristic, and no metastatic abscesses are present [3]

---

[1] T. Billroth. [2] Sir J. Paget. [3] L. Gosselin.

Septic fever usually appears two to four days after the injury; the wound often does not suppurate, but discharges a thin, bloody secretion, occasionally containing air-bubbles; in its vicinity very extensive inflammatory œdema occasionally develops within a few hours or days; the skin is of a peculiar reddish-brown color; the constitutional disease generally begins quickly, usually without chills.[3] Its grade will depend upon the quantity and quality of the absorbed fluids; it may have the severity only of a febricula, scarcely recognizable from the ordinary inflammatory fever of wounds, or it may have a distinct onset, with well-marked stages throughout; or, finally, it may overwhelm the patient suddenly, like the severest diseases, from blood-poisoning. The symptoms[1] develop as follows: patients are apathetic or sleepy, if not comatose; occasionally there is excitement, and even maniacal delirium; the fever at first rises high, but later the temperature falls to the normal or even below it; chills are very rare at first, and never occur in the course of the disease; the tongue is dry, often hard, interfering with speech; there is thirst, but patients are too apathetic to drink; there may be profuse diarrhœa, rarely vomiting; at first there may be great sweating, but later the skin is dry and flabby; the urine is scanty, concentrated, and occasionally albuminous; urine and feces are finally passed in bed; usually the patient dies in perfect collapse, with a thread-like and very frequent pulse. In the treatment: (1) remove from the wound all septic matters, cleanse with bichloride solutions and apply iodoform dressings; (2) support the vital powers until the absorbed poison is eliminated; nourishing food, stimulants, quinine, and iron, liberally, are the most useful; (3) change the patient's location to secure better surroundings; if the weather permit, remove him to the lawn, or balcony, but if this is not practicable, change his room for one having abundance of fresh air and sunlight.

Pyæmic fever, pyæmia, in its restricted meaning, has its source in venous thromboses which do not organize, but undergo a simple and more frequently putrescent softening, caused or at least favored by ichorous suppuration around the vein; emboli, produced from such thrombi, go from the right heart into the lungs, and become impacted in medium-sized and small arteries, or even capillaries, and cause metastatic abscesses, owing to their putrescent nature; they may reach the kidneys, spleen, liver, and other vascular organs. The symptoms usually set in suddenly, with a severe chill lasting several minutes to an hour; the temperature rises from 102° F. to 105° F. in a few hours; the chills recur during the first days, usually daily, rarely regularly, at times even several chills a day; less frequently they are entirely absent; the chill is followed by intense heat, and then profuse perspiration sets in; the skin may be dry or damp, occa-

[1] T. Billroth. [2] L. Gosselin. [3] E. Wagner.

sionally is covered with sudamina, later becomes more or less icteric; there is loss of appetite, great thirst, thickly coated and frequently dry tongue, and often painless diarrhœa; the face is haggard; there is general bodily and mental depression, and frequently headache; the organs affected with metastatic inflammation exhibit only moderate symptoms, and they are most marked when the respiratory organs and joints are affected; in the recent wound there is rapid decay of the injured tissues and intense inflammation of the surrounding parts, while in the granulating wound the secretion usually diminishes, pus becomes thinner, ichorous; or the wound bleeds, is painful, and granulations become smaller and flabby; the surrounding parts are œdematous, the veins and lymphatics give signs of thrombosis and inflammation, and the entire limb occasionally appears remarkably withered; death usually occurs after an acute course, lasting one or two weeks, more rarely a subacute, and still more rarely a chronic course, in which the chills decrease in number and intensity; recovery is extremely rare. The patient must be removed to the open air and sunlight, if practicable; the wound must be thoroughly examined and every part and recess cleansed of all septic matter, with the curette, and bichloride solutions, and iodoform dressings applied and retained. The most nutritive and easily assimilable foods, as milk, and beef-juice, should be given, with stimulants, and quinine and iron as tonics should be administered in as liberal quantities as can be borne. Amputation and disarticulation in acute septicæmia and pyæmia rarely have a permanently beneficial effect, but when these affections become chronic amputation may save life.[1]

Hectic fever is a continued fever, remittent, having great differences in the morning and evening temperature of the body, and is due to the constant absorption of the products of inflammation, especially of disintegration; it is most frequent and most intense from rapid breaking down of the inner wall of large abscesses, and progressive ulceration. It is always preceded by indisposition, and may begin suddenly with severe rigors, though generally it creeps on gradually and stealthily; the exacerbation is usually in the afternoon, lasts six to nine hours, then gradually passes off to reappear about the same time the next day; there may be two paroxyms in twenty-four hours; the chill may be long and severe, the patient occasionally shivering for hours, or the sensation of cold may be very slight and its duration variable; the chilliness is followed by reaction, usually violent in proportion to the previous depression, gradually merging into a profuse sweat, with tranquil and refreshing sleep; in the interval the pulse continues frequent and easily excited; the face is pale, shrunken, and careworn; emaciation begins early, and is progressive; the tongue is generally clean, often red at the tip and edges, or smooth and glossy; the appetite is good, often voracious, and though digestion continues, assimilation fails; there is coldness of the limbs, but the hands and feet are dry, hot, and burning; as the disease progresses, emaciation increases, the pulse daily loses power, sweating is more profuse; bowels often loose; evening exacerbation, with chilliness, is more severe, and morning remission more marked.

---

[1] T. Billroth.

Still later, all the symptoms are aggravated, the appetite begins to fail, aphthous spots occur on the tongue, œdema appears about the ankles and feet, chills and sweats which are colliquative succeed each other at shorter intervals, emaciation reaches an extreme degree, bed-sores form, the mind continues clear until near the close, when unconsciousness supervenes.[1] The first requisite in treatment is to relieve the system of the exciting cause. If it is an abscess, open it freely and remove with the curette every particle of granulation tissue and septic matters; cleanse with bichloride solutions 1–2000; pack iodoform gauze strips in all recesses; and change the dressings after four or five days. Or remove the diseased part, as in exsection of a carious joint, or amputation of a limb affected with an incurable source of suppuration. The second indication is to sustain the patient with tonics, as quinine and sulphuric acid, given in anticipation of the evening exacerbation, muriated tincture of iron, or other form, with wine, brandy, wine whey, ale, or porter; give easily digested and assimilated foods, as milk, eggs, meat-juice; finally, secure fresh air and perfect cleanliness.[1]

VII. NERVOUS AFFECTIONS COMPLICATING THE HEALING.

Affections of the nerves and of the nervous system following wounds are frequently troublesome and even dangerous complications of operation wounds.

Pain[2] may be excited by inflammation, foreign bodies, improper dressings, and wrong posture. It may appear (1) only as an exaggeration of the ordinary pain of wounds, severe and abiding long, through personal sensibility and so-called nervousness, and is usually continuous with the immediate pain of the wound, or commences not more than hour or two after it; (2) in some cases a wound is the beginning of a long-continuing neuralgia in or near the injured part; or (3) it is due to partial division of a nerve, or (4) the confinement of effusions under dense fasciæ. For the first form, hypodermic injection of morphia, or ice bladders, or opium in full doses, are proper remedies; the second generally resists all treatment, even section of the nerve; the third requires complete division of the nerve; the fourth is relieved by enlargement of the wound.

Spasms of the muscles[2] are frequent complications, especially of amputation and resection wounds; the startings of the limb are often among the most distressing symptoms; they occur as the patient falls asleep and the influence of the will on the muscles ceases, and the pain remains until the muscles are at rest; at any time uncontrollable quiverings and tremblings of the muscles may ensue, and lead to painful spasms. The remedy is posture and rest of the wounded part, sustained by splints, or other appliances, and assisted by opium or other anodynes.

Delirium tremens, following injuries and surgical operations on drunkards, or on persons of intemperate habits, is due to shock and its reaction, and the deprivation or stinting of stimulants which induce a peculiar impairment of the essential elements of the nervous structures.[1] The symptoms usually appear within two or three days after the operation; at first the patient is restless, sleepless, and talkative; then he has hallucinations and illusions of sight and hearing, which leads to attempts to get out of bed and escape reptiles and vermin, and to answer imaginary calls; next there is trembling of the tongue, hands, and limbs; the skin is moist and cool; the temperature normal; the tongue coated; the breath offensive; the eyes suffused. As the condition is one of debility, the great object of treatment is to enable the patient to take and to assimilate a sufficient quantity of proper nourishment.[2] The aim should be to fortify and stimulate the functions of the brain; mild preparatory purgatives may be required for the young and robust, but the debilitated must be sustained from the first; the typical stimulant is easily digested food,[3] and it is imperative that it be given regularly and continuously; the most desirable foods are milk with lime-water, soup or broth with bread in it, raw eggs beaten up, concentrated meats; irritation of the stomach requires ice, soda water, and other aërated drinks; the narcotic stimulants are useful, of which opium and cannabis indica are most valuable. Opiates may always be administered in the form of morphia hypodermically injected in the dose of $\frac{1}{10}$ to $\frac{1}{4}$ or $\frac{1}{2}$ a grain; if the circulation is enfeebled, ext. cannabis indica should be given in doses of $\frac{1}{4}$ to $\frac{1}{2}$ a grain; alcohol should not be given to young subjects, nor in any case where it can be dispensed with.[3] In some cases it may be found necessary to give good ale, porter, or wine, with solid food.[2] Bromide of potassium combined with the hydrate of chloral, the former twenty to thirty grains and the latter ten to fifteen grains at a dose, is a valuable remedy in quieting nervous agitation. Restraint should be made by an attendant and not by confinement with cords or strait jacket.

---

[1] S. D. Gross; J. Croft.

[2] Sir J. Paget.

Delirium nervosum[4] is allied to delirium tremens, but the trembling is absent; it is a state of excessive nervous exaltation, without fever,[5] occurring after injuries or operations attended by severe shock or loss of blood. It generally appears quite suddenly, within the first twenty-four or forty-eight hours after the application of the exciting cause, and rarely lasts more than five or six days; it may appear at a later period as a result of exhausting suppuration, and may even recur. The symptoms are confused, wandering, or flighty state of mind; excessive vigilance; incoherency of speech and manner; absence of fever; moist skin; quiet pulse; indifference to pain; wild expression of the eyes; intolerance of light, noise, and the presence of attendants; poor appetite; costive bowels; scanty urine.[6] The treatment should be sustaining and tranquillizing; mechanical restraint may be required; remove every source of irritation; correct any derangement of the digestive organs; give nourishing food and tonics; administer morphia hypodermically.

Tetanus is a spasmodic affection of the muscles, due to irritation of the spinal medulla and portio minor of the fifth pair.[5] The chief causes are cold and damp, and the injury of the operation.[7] The muscles of the jaw alone may be affected, trismus, or other groups may be involved. The symptoms appear as late as the third or fourth day after the injury, often later. In a well-marked case they develop in the following order: (1) there is a sense of suffering from a cold, with sore throat and stiff neck, an uneasy sensation and stiffness of the muscles of the lower jaw and tongue, rigidity of the back of the neck; (2) difficulty and pain in masticating and swallowing food, fixed and closed state of the lower jaw, severe pain with every effort to open the mouth; (3) convulsive cramp in all the affected muscles on any attempt to swallow; (4) sudden, violent, and continued pain, increased at short intervals by spasm extending from the ensiform cartilage to spine in the situation of the diaphragm; (5) constricted and hardened state of the abdominal muscles, giving the sensation of a board to the hand; (6) all of the voluntary muscles become involved, the head is thrown back and fixed, the extremities become fixed and rigid, the shoulders are drawn forward, the countenance is pale, anxious, and contracted, and disfigured with the tetanic grin; (7) the spasms become more and more frequent and violent, with hurried and laborious respiration, and quick, small, and irregular pulse; (8) the spasms may not be sudden, but may gradually draw parts into the form of a bow; (9) at the close the whole face becomes distorted and disfigured, the larynx forcibly drawn up, and in the majority of instances the case terminates in a paroxysm of spasm; (10) the intellectual faculties remain unimpaired. The bodily temperature varies greatly in different cases. The most marked indication of treatment is to alleviate the acute course, and make it more chronic. Of all the remedies used chloral has proved the most useful in allaying spasms and promoting the comfort of the patient. It may be given by the mouth or by the rectum, or it may be injected into the veins; the first method is to be preferred when possible; it should be given in doses of twenty to thirty grains or more, and repeated every hour or two until relaxation and sleep occur; its effects should be continued, except to allow the patient to wake and take food, until all danger is passed; if the chloral is not borne by the stomach or rectum, intra-venous injections may be resorted to. The solution may be as follows: gr. cxl of chloral (f℥iis) of water, with a few drops of a ten per cent. solution of carbonate of sodium. Two drachms of this solution may be injected and repeated once or twice in twenty-four hours if there is no accident; in case of syncope resort to the induction battery.[1] Division of the affected nerve is useful, but amputation of the injured member is rarely advisable.

---

[1] J. Croft.
[2] A. W. Barclay.
[3] F. W. Anstie.
[4] Dupuytren.
[5] T. Billroth.
[6] S. D. Gross.
[7] C. B. Radcliffe.

The Calabar bean has proved useful when given in such doses as paralyze the voluntary muscles.[2] Almost every other internal remedy has been successively tried, but no one individual medicine has proved an appropriate means of cure; they have been useful only as they have rendered the paroxysms less severe, and enabled the patient to resist the exhaustion caused by spasmodic action. It must be remembered that the disease will run a certain course, having its period of accession, its height of intense activity, and its gradual decline; nothing seems to check its progress, or control its unvarying and too often fatal career; all that can be done is to give the patient as much strength as possible, to avoid all useless applications and internal remedies, and all exposures to excitement and cold, and to watch day and night in order to protect and sustain him.[3]

[1] M. Nicaise.

[2] E. Watson.

[3] A. Poland.

CHAPTER XIV.

THE CICATRIZATION OF WOUNDS.

THOUGH the morphological changes are the same in wounds healing by first and second intention,[1] it is in the open wound, healing by granulation, that the several steps of the normal process, and the various complicating affections, may be most advantageously studied.

I. THE PROCESS OF NORMAL CICATRIZATION.

The injury sets up an inflammation which leads to an infiltration of cells at the borders of the wound; large numbers of migrated cells with a certain quantity of fluid are accumulated; parts of the existing tissue disintegrate by softening and liquefaction; a soft texture is in this way produced made up almost entirely of young round cells, with very little intercellular substance; some of these cells die and form pus-corpuscles, which are either thrown off with the secretions, or are absorbed, or are dissolved to feed the more vigorous living cells. Another set of cells begin to grow, their protoplasm increases in amount and becomes granular, the nucleus undergoes changes, and the cell becomes epithelioid, and this latter cell is the formative tissue of granulations.[2] The growth of granulations and of vessels going on beneath the suppuration reaches its physiological limit when they have arrived at the level of the surrounding skin; when this is attained, suppuration diminishes, and the formation of the epidermic covering, the skinning over, commences from the borders.[3] In association with shrinking of the vessels and of the tissue of the granulations containing them, the superficial extent of the wound diminishes, and at the same time the skin surrounding it becomes drawn towards the centre; at the part where the skin and granulations meet, the secretion of pus becomes somewhat diminished; first a dry, red border about one and a half lines in breadth forms and spreads towards the wound, and in proportion as this advances and covers the granulating surface, a clear, bluish-white border follows immediately after it, and is transformed into epidermis.[1] This bluish-white border, advancing from the edges of the wound towards the centre, is made up of young epidermis which allows the subjacent bloodvessels to shine through its thin layer with a bluish tint; at last the whole is covered with epidermis, consisting at first of mere polygonal, less flattened, and nucleated cells, which are frequently shed; later they appear more flattened, are in thicker layers, and have a longer duration; the scar, therefore, assumes a bluish tint so long as it is young; later, in proportion as the epidermic layers covering it become thicker, and a greater number of its vessels and those situated at a greater depth shrivel up and become obliterated, it appears whiter, smoother, and shining; the scar continues to contract for many months and years.[1] The rate of healing is ordinarily half an inch per week, those wounds healing most rapidly which correspond with the long axis of the body.[2]

---

[1] T. Billroth. [2] E. Ziegler. [3] M. Kaposi.

The subjective sensations caused by the granulations during normal cicatrization, as well as by the fully formed scar, are inconsiderable; healthy granulations possess a certain degree of sensitiveness to external irritation, and to the touch in particular, but this is far from being painful; diminished or increased sensitiveness is therefore an indication of an abnormal course; at the commencement, and in the course of the cicatrization of wounds of the skin, an itching sensation is often experienced in the immediate vicinity, which, however, has no prognostic value; completely formed scars are normally, not at all specially sensitive, though stretching or mechanical irritation of any kind may make them painful. Many persons complain of drawing, tearing, pricking, radiating pains occasionally felt in scars, which they connect, without cause, with changes in the weather.[1]

In normal cicatrization, the following indications of treatment should be carefully attended to at every stage: (1) the granulations must be protected from every possible source of irritation, as too frequent change of dressing, too much movement of the part, filth, retained secretions; (2) the granulations should never be broken so as to bleed, for such lesions are liable to be followed by the absorption of septic ferments;[3] (3) the direction and shape of the cicatrix should be so moulded or shaped by the dressing as least to impair the function and symmetry of the part.[4]

II. FORMS OF DISEASED GRANULATIONS.

The granulating surface is liable to undergo many changes which modify the process of cicatrization. The formation of the epidermis may thus be interfered with, or the epidermis alone may suffer delay or interruption.[1]

Erethitic granulations[5] are characterized by great pain on the slightest provocation; are very proliferous, and readily bleed; occasionally they are so sensitive as not to endure the slightest touch, nor any dressing, but a less degree of sensitiveness is more common. The cause is uncertain, but may be due to a peculiar degeneration of the ends of the nerves at the floor of the wound. The entire granulating surface, or at least the painful part, must be destroyed without delay by excising the surface with the knife, and after disinfecting with bichloride solutions dressing with iodoform. If hysteria or anæmia exist, tonics, as iron and quinine, and remedies which relieve general irritability, valerian, assafœtida, should be employed.

Croupous granulations[5] form a yellow rind on part of the surface, readily detached, and composed of pus cells very firmly adherent to each other. The membrane re-forms even a few hours after its removal, and this is repeated for several days, till it either disappears spontaneously, or finally ceases on cauterization of the affected part.

[1] M. Kaposi.
[2] G. W. Callender.
[3] J. Lister.
[4] G. J. Swerchesky; Langer.
[5] T. Billroth.

If disease of the granulating surface be accompanied by swelling, great pain, and fever, there is a true, acute inflammation of the wound, which usually ends in sloughing of the diseased granulations. The treatment is purely local; any causes of new irritation should be sought out and prevented; the fibrinous rinds should be daily removed, and the exposed surface cauterized with nitrate of silver, or painted with tincture of iodine.

Indolent granulations[1] may become completely papillary, and form a flat surface, which, instead of being vividly colored, is of a brownish-red tint, finely granular, secretes a little thin serous pus, and frequently, owing to drying up of this secretion, appears as if smeared over with varnish, dry, glistening, and iridescent; or the surface of the wound has a shining, oily appearance, or its upper layers break down into a fatty, greasy pulp; in this indolent condition the wound may remain for weeks or months without markedly altering its level, and without cicatrization taking place from the periphery inwards. Or, the granulations, having shot forth luxuriantly, may be easily lacerated, bleed freely and frequently; hemorrhagic effusion takes place into them, by which they become of a bluish-red color, degenerate, shrivel up, decay into shreds, and are cast off; or the abundant granulations are dropsical, soaked with fluid, of a pale rose tint, and transparent. Such granulations do not favor cicatrization, as they do not afford a sufficiently firm support for the advancing border of epidermis, and are easily destroyed. This condition of the granulations occurs more often in persons of impaired nutrition from whatever cause, as anæmia, cachexia, scrofula; or if suffering from febrile excitement; or it may be due to local irritation of the wound, as pressure, friction. The treatment should be the complete removal of the granulations with the spoon and the application of iodoform dressings. After the surface of the wound has been freed from any dead, gangrenous, diphtheritic, hemorrhagic coating, and granulations are seen springing up everywhere, we have a valuable addition to our means of treatment in the transplantation of epithelium and portions of skin.

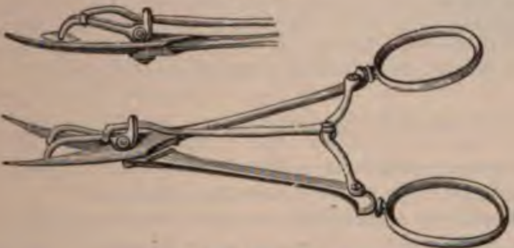
The procedure[2] is as follows: Prepare the wound by securing a healthy granulating surface; take the grafts from very vascular skin, as the sides of the chest and the front of the legs and arms; with the point of a common needle raise the integument, and with the knife cut out a small piece of true skin, without adipose tissue; cleanse the surface of the wound with bichloride solution; lay the grafts upon the granulations with the raw surface downward; place the first near the margin, and the remainder about one inch apart, as this is the ordinary limit of their growth; dust the surface with iodoform and apply absorbent cotton lightly fastened with a bandage. Keep the part at rest for six days, when the dressings are to be very carefully removed, the surface cleansed by irrigation with bichloride, and sprinkled with iodoform. The graft may be taken with scissors having a self-acting forceps (Fig. 82). When the dressings are first removed, what appear to be the grafts may be seen lying where they were originally placed, or floating loosely about; sometimes they have disappeared altogether. On the seventh to the tenth day there is a bluish-white opaque appearance at the seat of the successful graft, which indicates skin formation. At the same time there is a projection of new skin from the margin of the ulcer towards the nearest graft, which finally forms a bridge, and the graft is lost in the surrounding integument, and becomes in its turn the outer margin of the greatly diminished ulcer. Finally, all the grafts coalesce, each contributing an inch or less to the completion of the cicatrization.

---

[1] M. Kaposi.

[2] M. Reverdin.

Fig. 82.



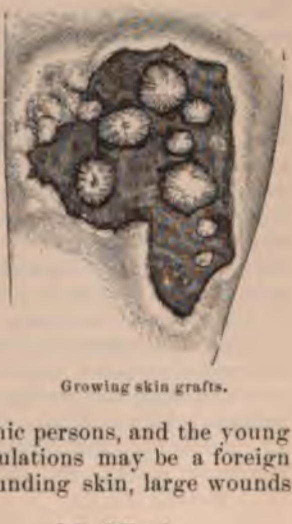
Skin grafting scissors.

Sponge[1] has been successfully employed in grafting as follows: The sponge is prepared by dissolving out all the calcareous and other salts with nitro-muriatic acid; it is then washed in a solution of ammonia or potash to remove the acid; it is then purified in a five per cent. solution of carbolic acid. The granulating surface having been prepared as before, a thin section of the sponge is applied and covered with lint treated with carbolic oil, and over this antiseptic gauze is wrapped. The sponge is believed to sustain the vessels of the granulations and thus form a framework for their growth. Successive layers of sponge may be used as the granulations increase in size.

By grafting, the most extensive open wound, which could not by any other method be completely healed, rapidly cicatrizes, and becomes in no considerable time firmly repaired (Fig. 83).

Exuberant granulations[2] exist when they rise above the level of the skin, and lie over the edges of the wound like fungus. They are usually very soft; the pus secreted is mucous, glairy, tenacious, contains fewer cells than good pus, and most of the pus cells, like granulation cells, are filled with fat globules and mucous material, which is also more abundant than normal as intercellular substance. The development of vessels may be very prolific, and the fragile tissue often bleeds on the slightest touch, but occasionally the granulations are of a very dark-blue color; in other cases the development of vessels is very scanty, the surface light red, or in spots even has a yellowish, gelatinous appearance in anæmic persons, and the young and old. The cause of proliferating granulations may be a foreign substance in the wound, rigidity of surrounding skin, large wounds

Fig. 83.



Growing skin grafts.

---

[1] J. Hamilton.

[2] T. Billroth.

which contract slowly. Cicatrization will not progress properly until the granulations have been brought to the level of the skin.

For the purpose, the daily application of nitrate of silver along the edges, and its repetition when the white slough which it forms separates, is very useful; also powdered red oxide of mercury sprinkled daily on the surface. Astringent lotions, as decoction of oak or cinchona bark, and lead-water are useful where the proliferation is less; compression with adhesive plasters acts well occasionally. If the granulations are exceedingly dense and large, they may be cut off with scissors, the bleeding being arrested by charpie.

III. MORBID CONDITIONS OF THE CICATRIX.

There are many variations in the cicatrix which have a morbid condition or tendency, and require care and treatment.

The defective cicatrix[1] remains thin, weak, vascular, moist, easily breaking out, and yielding so as to expose the subjacent structures; it indicates a failure or incompleteness in the last stages of healing, a deficient development of cuticle, and too little contraction of the granulations or bond of adhesion. Such scars are most frequent after wounds healed by granulations that have become œdematous, soft, and puffy, whether through disease or the constriction due to the contraction of tissues healing round them; they are common after wounds that heal slowly, and in weakly patients. Such scars are prevented by cauterizing exuberant and œdematous granulations with nitrate of silver or sulphate of copper, and dressing them with solutions of those, or other astringent lotions.

Similar solutions are useful for the scars themselves, as also the bichloride of mercury in spirit. Scars should always be warmly and dryly covered, as they are sensitive to cold, and this protection may be required for many months.

The exuberant cicatrix[1] presents various forms in its frequent combinations, with their indurations and degeneracies. In its simplest condition, it appears only as a thick or lumpy scar, which projects from the surface instead of being plane or depressed; it sometimes follows the operation for hare-lip, and here shows its worst quality, as it is unsightly and apt to contract long after its formation. Similar scars occur after vertical wounds through the eyelids. These scars cannot always be avoided, for they are sometimes due to constitutional defects, as in scrofulous persons; but when their deformity would be troublesome, the most scrupulous means should be adopted to obtain immediate union of the wound. When they are formed, the absorption of the lowly organized new structures, of which the scars are composed, is best promoted by the repeated application of stimulants or vesicants, as the strong solution of iodine, or blistering fluid.

The adherent cicatrix[1] adheres too much and too long to the adjacent structures, and thus falls short of that stage of improvement in which there is a gradual loosening of the tissue, a part of the normal process, which at first unites a scar to the parts beneath or near it. The persistence and excess of scar-tissue existing in the failure of this loosening process are often grave inconveniences, either from deformity, or by rendering the scars liable to ulceration, or by interfering with their nutrition. The relief of this condition is difficult; the best means are friction, shampooing, steaming, and, if the tissue is abundant, stimulants or vesication; but all remedies must be used very gently when the scar adheres to bone.

---

[1] Sir J. Paget.

The contracted cicatrix[1] may follow any wound, but is most frequent in those which involve strong fasciæ, and after deep burns; in some cases the scar appears only to contract, but in more it becomes very dense, hard, toughly fibrous, nodular, and lumpy, and usually adheres closely to the structures near it. The certainty of considerable contraction of the scar of a wound healed by adhesion or granulation, and the possibility that it may be excessive, must be regarded in every surgical wound involving parts in which contractions would be mischievous. The length of a wound should, if possible, be in that direction in which subsequent shortening will be least important; and it may often be necessary to make provision against contraction of scars by lateral or other incisions, or by plastic operations. When no provision can be made, the healing must be carefully watched, and some elongating force must be applied in the direction to counteract the contraction; if near the joints, the tendency to contraction must be overcome by splints with screws, or elastic bands or cords, whose persistent recoil after being stretched will exercise a force more powerful and not less constant than that of the scar. Elongation may be assisted by frequent application of moist heat, or shampooing, and other means of softening and causing partial absorption of the scar-tissue; the treatment must be continued as long as the disposition to contract exists. If the contraction finally impairs the function of a part, it may be necessary to dissect out the cicatrix and transplant healthy skin to the wound.

The painful cicatrix[1] is most common after amputation, but may occur in the scar of any wound. The cause of the pain is often obscure, and the more so owing to its commencement in some cases a long time—it may be years—after the healing of the wound, and without visible change in the scar. But in stumps it is nearly certain that the pain is due to a morbid condition of the ends of one or more of the divided nerves; not to the bulbous swelling common in the healing of nerves, generally painless, but to morbid adhesions of the nerves to the end of bone or to skin, so that they are kept in constant irritation, or are inflamed. In other cases no such condition can be found, and the cicatrix can only be called neuralgic. When the pain of a scar depends upon adhesions or other such morbid condition of the nerves, subcutaneous division may be practised;[2] when wounds have been allowed to heal with the limb bent, or otherwise misplaced, the neuralgia seems to be due to compression, and recovery follows restoring the normal movements with douche and friction.[3] When these measures fail, or the case is one of obscure and severe neuralgia, the treatment must be that of ordinary neuralgic affections, namely, quinine, belladonna, and other narcotics, the local application of anodynes, or excision.

[1] Sir J. Paget.

[2] H. Hancock.

[3] S. W. Mitchell.

II.

THE OSSEOUS SYSTEM.

THE BONES; THE JOINTS.

CHAPTER XV.

INJURIES OF BONES AND SPECIAL OPERATIONS.

VIOLENCE applied to bone results in lesions analogous to those produced by the same causes on the soft tissues. Contusion may be followed by the inflammatory process, and the results appear among the diseases of bone. Fracture is the counterpart of the wound of the soft tissues and demands immediate care, either in operative procedures or in the employment of adjusting and retaining appliances. It is important on first approaching a patient,[1] especially a child, suffering from fracture, to inspire him with a confidence that he is not to be unnecessarily hurt; sit quietly beside him, and inquire minutely into all the circumstances relating to the accident; remove the clothes from the injured limb with the utmost care; notice its position, contour, points of abrasion, discoloration, or swelling; pass the fingers lightly along the surface of the limb, pressing more firmly at points where there are appearances of injury; finally, to solve all doubts, grasp the limb so as to make traction of the lower fragment, rotate to obtain crepitus, and make lateral motions to indicate the false point of motion; in the application of the necessary dressings, let gentleness and a manifest regard for the patient's sufferings characterize every act; and, throughout the subsequent treatment of the case, proceed slowly, thoughtfully, and systematically, for rude and awkward manipulations, by which pain is needlessly inflicted, are frequent sources of inflammation, suppuration, and gangrene.

Fractures are variously classified, but in practice the important distinction is as to their being subcutaneous or compound, for on the determination of this question depends the immediate and subsequent treatment. Under these two essential divisions all minor distinctions, as the direction of the fracture, its complications, its extent, may be arranged and considered.

---

[1] F. H. Hamilton.

I. SUBCUTANEOUS FRACTURE.

The subcutaneous fracture may be partial or complete, single or multiple, transverse or oblique. Whatever form it takes it does not tend to suppuration, and hence never suggests any other treatment than what pertains to the proper employment of suitable apparatus.

The diagnosis of fracture depends chiefly upon the presence of one or more of the following signs: (1) crepitus, obtained by rotating the lower fragment; (2) preternatural mobility, produced by lateral movements of the fragments; (3) spontaneous displacement when reduction of the fragments has been effected.

The prognosis must depend upon the kind of fracture, the bone involved, and the complications which may exist. Single transverse fracture is always the most favorable. It must also be borne in mind that fractures are liable to unexpected complications, as delirium tremens, traumatic delirium, erysipelas, tetanus, fatty embolism. All of these diseases are readily diagnosed, and the treatment known, except the last. The occurrence of sudden dyspnœa a day or two after fracture, with rapid and feeble pulse, pallor or cyanosis, delirium, coma, and death, has been found due to fat globules in the blood-vessels and especially in the capillaries of the lungs; these oil-cells are believed to have been absorbed from the injured medulla. Stimulation of the heart's action is the only remedy.

The treatment of subcutaneous fractures must be governed by the following rules:[1] 1. To effect reduction at once and with as little disturbance of the limb as possible; 2. To apply no bandage to the part of the limb fractured, nor under the apparatus; 3. To pad all apparatus thickly; 4. To include and fix in the apparatus the two joints connected with the injured bone; 5. To disturb the apparatus as seldom as possible; 6. To use starch, pasteboard, or plaster apparatus when practicable, in preference to any more special form of appliances.

The fragments may usually be placed in coaptation by extension and counter-extension with the hands; but should such means fail, anæsthetics must be used, and even pulleys.[2] Maintenance is accomplished by side or coaptating splints, by long or extending splints, by the weight and pulleys, by plastic apparatus, or by a combination of these methods. Of the several appliances, the plastic apparatus, in its various forms, most effectually secures and maintains coaptation, but used as a bandage when the fracture is accompanied with such injury to the soft parts as to render subsequent inflammation inevitable or probable, this form of dressing exposes to congestion, strangulation, and gangrene.[3] As safety in the use of this dressing depends much upon the skill and care of the surgeon, the rule should be never to resort to it unless familiar with all its peculiarities, and in a position to give the case necessary care.[4] When employed, the provisional callus will always be less, and hence firmness will result later, yet the formation of definite callus will not be disturbed.[2] But these objections do not apply to the different forms of gypsum splints,[5] which can be readily and perfectly adapted to support the limb and not endanger it by strangulation. These splints should be applied in the first stage of the case; swelling from contusion and subcutaneous laceration, uncomplicated with lesion of the vascular trunks, is not an objection to the immediate application of the apparatus; on the contrary, the support and enforced rest have a beneficial influence in controlling swelling and its consequent pain. As a rule, no bandage should at first be applied directly to the skin.[1] The dressings adapted to individual fracture must necessarily vary very much, but it may be stated as a principle applicable to each case that that apparatus is the best which, whilst it answers the indications equally well, exacts the least amount of skill and attention.[1]

---

[1] J. E. Erichsen.

[2] T. Billroth.

[3] F. H. Hamilton.

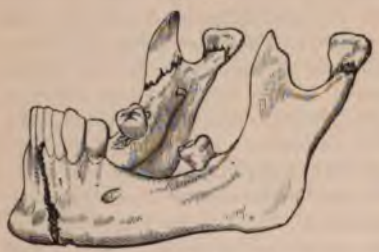
[4] A. C. Post.

[5] J. Croft.

BONES OF THE FACE.

The ossa nasi,[1] when fractured, are depressed, causing considerable deformity. In reducing the fracture, first apply a four per cent. solution of cocaine to the mucous surface involved, which will arrest hemorrhage, and enable the operator to introduce, without pain, the small end of a director and elevate the depressed bones to their proper places. They may require the support of external apparatus, as lateral compresses of cotton or lint, fixed by adhesive plaster. A needle may be used to transfix the nose just below the fragments.[2] Fractures of the septum may be placed in position by first using cocaine, and then adjusting the fragments; plugs of proper size may be introduced, moistened with carbolized solution, to maintain the bones in place.

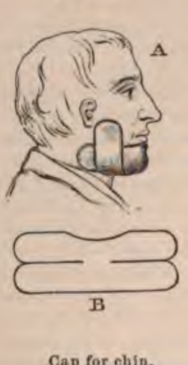
Fig. 84.



Fracture of the lower jaw.

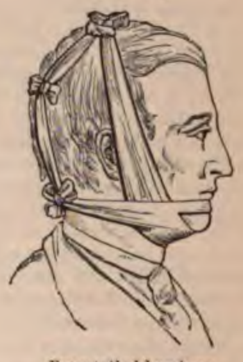
The inferior maxilla may be fractured at any point of the body and of the rami (Fig. 84), or two fractures may occur. The diagnosis is very readily made. Of the variety of apparatus constructed, the most convenient and serviceable in general practice are interdental gutta-percha supports or splints, and an external sole-leather or binder's board cap for the chin, held in position by the four-tailed bandage (Figs. 85 and 86).

Fig. 85.



Cap for chin.

Fig. 86.



Four-tailed bandage.

---

[1] F. H. Hamilton.

[2] L. D. Mason.

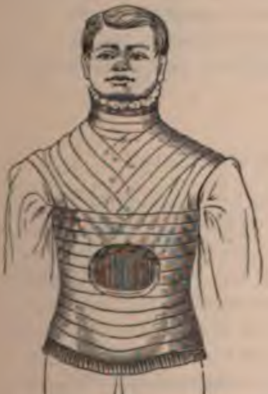
The interdental splints consist of wedge-shaped masses of gutta-percha, which are softened by hot water, and then introduced between the teeth on both sides, the fracture being reduced; the lower jaw is now firmly pressed upward against the splints; the gutta-percha being hot is soft and receives the impression of the teeth above and below; on removing the splints they soon become hard; they are again introduced, the teeth fitting the indentations, and the external dressings firmly applied.

Union is complete in three weeks; non-union is very rare.

BONES OF THE TRUNK.

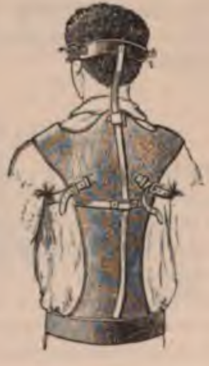
The vertebræ are liable to a variety of fractures, but they are unimportant, except when there are evidences of pressure upon the cord. If fractures in the lower cervical, dorsal, or lumbar regions are diagnosed, and the cord is not involved, perfect rest of the bones is necessary until repair is complete. This is best secured by the plaster-of-Paris jacket carefully applied, while the patient is maintained in the erect or sitting posture. If the cord is compressed, extension and counter extension may be made, on a hard, smooth bed, to relieve the pressure; continuous extension by elastic straps may be substituted. Operations to elevate the fragments have proved unsuccessful. Fractures of the atlas and axis are known by inability to move the head firmly immediately after the injury. The odontoid process may be fractured off, and the patient be able to pursue his business, but his head is so unsteady and unsupported, that he is compelled to place his hands under his chin and occiput, or on the sides of the head in lying down or rising, or in stooping and turning from side to side. Fractures in this region should be treated by complete rest in the recumbent position, the head, neck, and shoulders being fixed in immovable plaster-of-Paris apparatus (Fig. 87), or a moulded leather or felt splint. A neat and serviceable apparatus for fractures of the spine not requiring complete immobility, may be applied (Fig. 88), which fixes the head and spine.

Fig. 87.



Plaster-of-Paris apparatus.

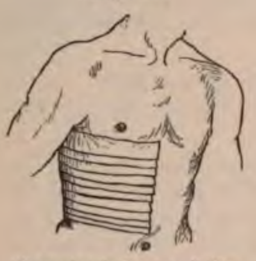
Fig. 88.



Apparatus in fracture.

The ribs and cartilages are more often fractured in advanced life; the displacement is usually very slight, and not easily overcome, but union takes place quickly, even when quietude is not secured. Emphysema, due to injury of the lung, is quite common, and generally demands no special attention; but, if very extensive, it may be necessary to make an incision, or to open the part down to the point of fracture, to allow the air to escape. Union takes place in about one month. The fractured rib may be efficiently maintained in a state of rest by the application of strips of strong adhesive plaster (Fig. 89) two inches broad, extending from the sternum to the spine, covering in the seat of injury and at least three inches of surface above and below it; each strip is so applied as to overlap half of the preceding.[1]

Fig. 89.



Strapping in fractured ribs.

If several ribs are fractured, they may be maintained in very accurate apposition by a broad band of adhesive plaster. Cut the plaster of a width equal to one-half the depth of the thorax, and of sufficient length to extend once and a half around the body. Place the strip under the patient, while recumbent, so as to inclose the lower half of the thorax, the adhesive side internal, and while he is in the act of forced expiration pass one end firmly over the thorax and the other in the opposite direction over the first; there is now a sense of suffocation, which is soon followed by relief; the pain quickly subsides; do not change the dressing until the cure is complete.

The sternum is occasionally fractured, but more frequently the manubrium is displaced from the gladiolus as a luxation. The displaced bones are usually quite prominent, the lower fragment often moving with respiration; crepitus may sometimes be found. The fragments may generally be reduced by suitable pressure; they must be retained as far as possible by adhesive plaster bandage fastened during expiration.

BONES OF THE UPPER EXTREMITY.

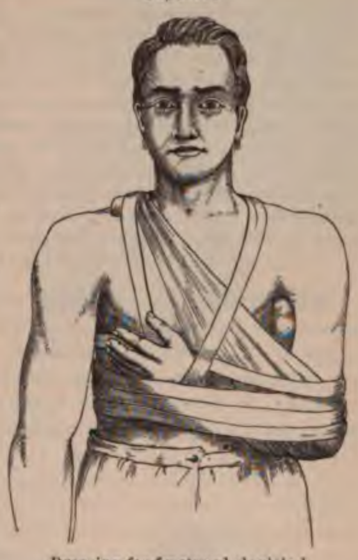
The clavicle fractured is replaced by supporting the shoulder in an upward and backward direction. This position is most perfectly secured in the recumbent posture, with an unyielding pillow, broad, and long enough to cover the whole back of the chest, and slightly inclined from above downwards, allowing a somewhat greater elevation for the head and shoulders than for the loins or waist, the depth of the upper margin not being greater than eight or ten, and of the lower two to three, inches; this position need not be retained more than ten to fourteen days.[2] No apparatus completely maintains the reduction sufficiently long to insure a perfect union, but the following method secures all the advantages yet attained: Pass a sling under the elbow of the wounded side, and tie it to the opposite shoulder; insert a well-fitting axillary pad, but not so large as to be a fulcrum; apply a bandage around the body, so as to secure the elbow against the trunk[1] (Fig. 90).

---

[1] Hannay.

[2] E. Hartshorne.

Fig. 90.

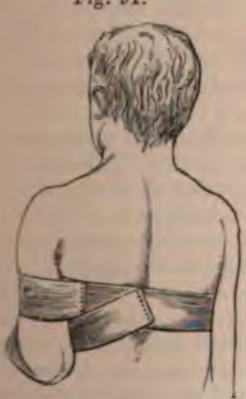


Dressing for fractured clavicle.[1]

In cases where the displacement persists in spite of the ordinary dressings, the patient may be placed on his back in bed, with the head neither to one side nor to the other, but sufficiently elevated to bring the chin well towards the sternum; this position will sometimes remove immediately all disarrangement of the fragments, and if continued five or six days the patient may rise without any tendency to a return of the displacement.[2]

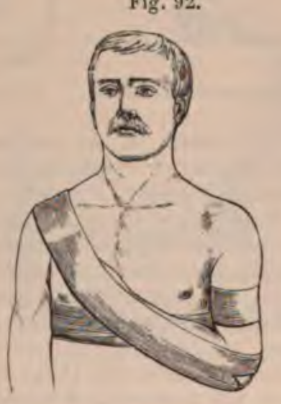
Adhesive plaster[3] may be applied: Select strong adhesive plaster, and cut it into two strips three or four inches wide, but narrower for children; one should be of length to encircle the arm and the body, and the other to reach from the sound shoulder around the elbow of the fractured side and back to the place of starting. Pass the first piece around the arm just below the axillary margin, and stitch in the form of a loop sufficiently large to prevent strangulation, leaving a large portion on the back of the arm uncased by the plaster; draw the arm downward and backward until the clavicular portion of the pectoralis-major muscle is put sufficiently on the stretch to overcome the sterno-cleido mastoid, and thus pull the inner portion of the clavicle down to its level; carry the plaster smoothly and completely around the body, and pin to itself on the back to prevent slipping (Fig. 91). This first strip of plaster fulfils a double purpose: first, by putting the clavicular portion of the

Fig. 91.



First adhesive strip.

Fig. 92.



Second adhesive strip.

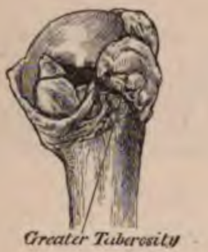
---

[1] F. H. Hamilton. [2] D. H. Agnew. [3] L. A. Sayre.

pectoralis-major muscle on the stretch, it prevents the clavicle from riding upward; and, secondly, acting as a fulcrum at the centre of the arm, when the elbow is pressed downward, forward, and inward, it necessarily forces the other extremity of the humerus (and with it the shoulder) upward, outward, and backward. And it is kept in this position by a second strip of plaster, which is applied as follows: Commencing on the front of the shoulder of the sound side, draw it smoothly and diagonally across the back to the elbow of the fractured side, where a slit is made in its middle to receive the projecting olecranon (Fig. 90). Before applying this plaster to the elbow, an assistant should press the elbow well forward and inward and retain it there, while the plaster is continued over the elbow and fore-arm, pressing the latter close to the chest, and securing the hand near the opposite nipple; crossing the shoulder at the place of beginning, it is there secured by two or three pins.

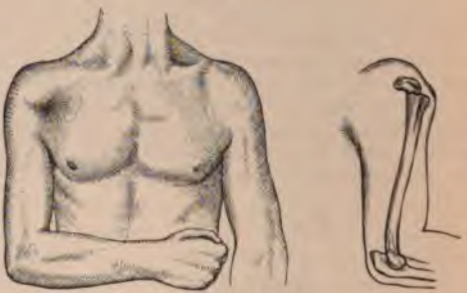
The humerus may be fractured: 1. At the anatomical neck, or about the insertion of the capsule; it is often impacted; there is no marked displacement; crepitus is present, if not impacted. 2. At the anatomical neck with the tuberosities (Fig. 93); symptoms same as first. 3. Separation of epiphysis (Fig. 94), occurs in children more often on the right side; head of the bone can be felt, but it does not move with shaft. 4. At surgical neck, or that part of the shaft lying between the upper epiphysis and the insertions of the latissimus dorsi and pectoralis major (Fig. 95); it is the result of direct violence; the lower fragment is drawn inwards; the diagnosis is easy. 5. In the shaft when the diagnosis is clear. 6. At base of condyles; often difficult of diagnosis owing to swelling; most reliable signs are mobility, crepitus; easy reduction, but immediate return of deformity; great prominence of olecranon, like a dislocation; pronation of hand. 7. At the base of the condyles with longitudinal fracture between them, sometimes comminuted (Fig. 96); this fracture has the same symptoms as the last with widening of joint and crepitus of condyles. 8. Fracture of either condyle, known by separate movement of the condyle. 9. Separation of epicondyles, detected by grasping the fragments. In treatment the fragments, at any point above the elbow, should be maintained in position as follows: Select a piece of leather, gutta-percha, felt, or binder's board, long enough to extend from above the acromion process to the elbow-joint, and wide enough to inclose about one-half of the circumference of the limb; mould it while

Fig. 93.



Fracture of head of tuberosities.

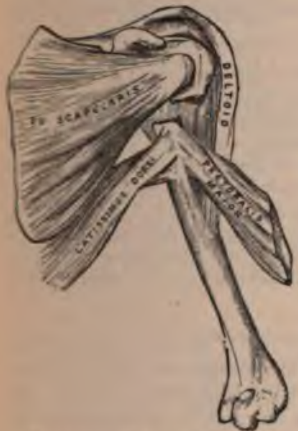
Fig. 94.



Separation of shaft of humerus from upper epiphysis.

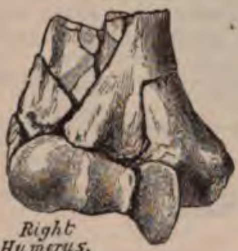
wet to the outside of the arm, and allow it to become dry; prepare a short splint for the inside of the arm: cover each splint with a sack of woolen cloth; reduce the fracture and apply the splints to the arm with a roller bandage, and secure the arm to the body with a second roller bandage passed around the latter; flex the fore-arm, and suspend by a sling. No bandage is required for the fore-arm; slight overlapping may be anticipated. If the fracture is at or near the elbow-joint, the fore-arm must be placed and maintained at a right angle with the humerus by means of a gutta-percha, leather, felt, or binder's board splint, moulded to fit the shoulder, arm, and fore-arm, and well padded; place the fore-arm at a right angle with the humerus, and maintain it in this position by a right-angled splint; cover the splint with a woollen or cotton sack, and secure it to the fore-arm by a roller.[1] In a case of fracture of the humerus above the condyles, while extension is made, secure the upper portion of the splint to the arm in a similar manner. The front or bend of the elbow should always be well covered with cotton batting before inclosing the elbow-joint in the turns of the roller to prevent strangulation. Passive motion must be commenced very early by loosening the dressing, supporting the parts at the joint, and making flexion and extension. If the fragments are not disturbed, repeat this manœuvre daily.

Fig. 95.



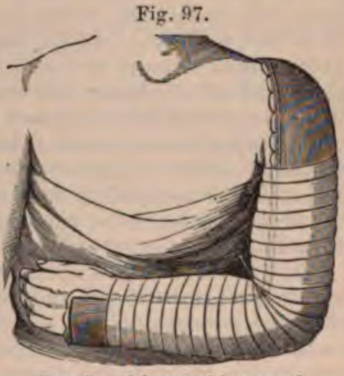
Fracture at the surgical neck.

Fig. 96.



Comminuted fracture of condyles.

Fig. 97.



Dressing of fractured humerus.[1]

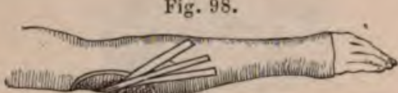
The olecranon process separated from the ulna requires the straight position of the fore-arm. Apply a light but firm splint, extending from about four inches below the shoulder to the wrist, wide as the arm at its widest part, thickly padded with cotton batting to meet the irregularities of the arm, and having a notch cut about three inches below the olecranon; place it on the palmar surface, and apply a strip of adhesive plaster, the centre being on the process and the ends drawn firmly through the notches and fastened to the splint; retain the splint in position by a bandage or strips of plaster passed circularly around the limb and splint.

---

[1] F. H. Hamilton.

The plaster-of-Paris is applied as follows: Place the limb in extreme extension; cover it with cotton batting or flannel; apply three layers of bandage, and when it is hard cut out a large fenestrum over the olecranon; now apply strips of adhesive plaster, the centres being over the upper surface of the olecranon, and fasten the ends, drawn down firmly, to the sides of the splint (Fig. 98). Over this fenestrum apply a roller bandage firmly.

Fig. 98.



Dressing of fracture of olecranon.

The ulna may be fractured in any part of its shaft by direct violence; the diagnosis is readily made The treatment is by lateral splints, the bones being parallel and separated by small pads on the anterior and posterior aspect; the splints should be wider than the arm, and be retained in position by two adhesive strips, one near the elbow and the other near the wrist, passed completely around the splints.

The radius may be fractured through its head, generally in injuries involving the joint. Adjust it and apply an angular splint, supporting the elbow in a state of flexion. If the neck is fractured, the biceps will elevate the lower fragment; the treatment is the same as the former accident. All fractures above the attachment of the pronator quadratus must be so adjusted that the proper axis of the bone is maintained, to secure the restoration of its normal movements.[1] The elbow should be semiflexed, the fore-arm and hand, excepting the fingers, supported between a dorsal and a palmar splint padded, and secured by adhesive plaster passed completely around the splints; the limb should be accurately fixed in supination at an angle of 120° by means of angular pads; the thumb in this position is brought nearly into a line with the outer fleshy border of the supinator radii longus.[2]

Colles fracture occurs at the lower extremity of the radius, being from three-eighths to one and three-quarter inch on the posterior, and one-quarter to two inches anteriorly from the articular surface.[3] It is usually the result of a fall upon the palm of the hand, in which two forces act in an opposite direction, viz., the weight of the body and the resistance of the ground; the bone yields nearest the point of impact, where the vibration is greatest and the bone is weakest, viz., the junction of the compact and spongy tissue.[4] The chief deformity is due to the projection of the lower end of the radial fragment upon the palmar surface, and of the carpal fragments upon the dorsal surface, which give the peculiar silver-fork appearance. The diagnosis is readily made as this deformity is usually marked; crepitus is present unless there is impaction.

---

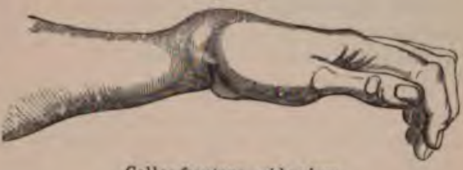
[1] J. H. Packard.

[2] G. W. Callender.

[3] Gordon.

[4] F. H. Hamilton.

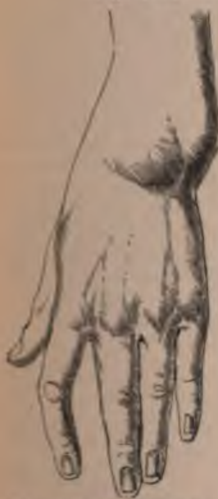
Fig. 99.



Colles fracture—side view.

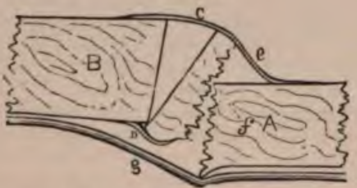
In looking sideways at the hand and forearm, held midway between pronation and supination, there is a considerable dorsal prominence apparently just above the back of the carpus (Fig. 99); immediately under this on the palmar aspect of the wrist, just opposite the annular ligaments, there is a hollow or arch confined to the radial side; a little above this on the anterior aspect of the arm is another prominence not so large nor so distinct as the one on the dorsal surface; the hand is abducted and rotated outwards; the ulnar border is somewhat convex, and the styloid process of the ulna projects sharply under the skin (Fig. 100); the radial side is somewhat concave and appears to be shortened.[1]

Fig. 100.



Colles fracture—posterior view.

Fig. 101.



A. Radius. B. Carpus. *e*. Dorsal periosteal-pseudo ligament. *f*. Point of entanglement. *g*. Flexor tendons.

In some cases the styloid process is dislocated,[2] and in reduction the process must be removed from its position beneath the annular ligament. If the violence which caused the fracture is considerable, the position of the fragments have been represented as in Fig. 101.[3]

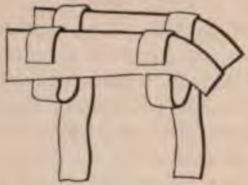
In the treatment, two forms of fracture must be recognized, namely, those without and those with displacement. The first is likely to be called a sprain and to be treated as such; for immediately upon the recovery of the hand from the over-extension which it had sustained, the corresponding surfaces of the fragments fall together, where they are held by the weight of the hand when prone; there is no tendency to displacement. The indications are: 1. That the wrist should be supported in the prone position, with the hand hanging loosely, and thus maintain the fragments in apposition. 2. That movements of extension of the hand should be limited, lest separation of the fragments again occur. The first indication in the treatment of the second form is to overcome the displacement, which is effected as follows:

[1] J. E. Erichsen. [2] E. W. Moore. [3] L. S. Pilcher.

Bend the hand and wrist backward, approximating the position in which the parts were when the displacement took place, and relax the tense periosteum. Slight extension now in the line of the forearm is sufficient to disentangle the rough surfaces of the fragments from each other, and moderate pressure upon the dorsum of the lower fragment causes it to fall into line; the weight of the hand is now sufficient to secure apposition of the fragments. A great variety of splints have been recommended for this fracture. The most simple and effective apparatus is made as follows:—

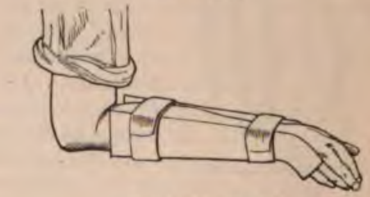
Take two thin but firm pieces of board, each a little wider than the entire arm; make both of the splints slightly pistol-shaped at the lower extremity; they should extend from a point two inches below the bend of the elbow, when flexed, to the middle of the prominence of the metacarpal bones of the hand (the splint for the posterior surface may be straight, and extend from a point opposite the anterior splint to the carpus); place a layer of cotton batting, thickest in the middle, along the surfaces of the splint next to the limb; over the dorsal and palmar prominences at the wrist arrange the cotton into the form of compresses, and cover the whole splint with a bandage; next cut two strips of adhesive or rubber plaster, each two and a half inches wide and twenty-four inches in length; apply one end of each to the outer side of the palmar splint (Fig. 102), the adhesive surfaces next to the splint, the upper strip being near the upper end, and the lower strip at a point which will bring its lower margin under the styloid process of the ulna. Place this splint, with the adhesive strips depending, upon the anterior surface of the forearm with the bent palmar extremity pressing on the prominence of the metacarpal bone of the thumb; bring the adhesive strips around and over the forearm, making loops in which the limb rests, the adhesive surface presenting externally; lay the other splint on the external surface of the arm, the strips of plaster being between it and the arm, and adhering to the splint; bring the strips over the external splint, and then under the arm to the inside of the limb; thence over to the outside completely around both splints as far as the strips will extend (Fig. 103).

Fig. 102.



Position of strips on the splints.

Fig. 103.



Dressing completed.

When properly applied, this dressing has the following advantages: 1. The limb is uncovered. 2. It is supported in a sling between the splints. 3. Pressure may be accurately made on the dorsal and palmar deformities. 4. Pressure is made on the projecting styloid process of the ulna. 5. The hand is maintained in a position between pronation and supination. 6. If the dressing proves too tight, any one may loosen it by raising the ends of the plaster sufficiently, and then reapplying them, without affecting its efficiency. 7. The wrist has free backward motion. When the dressing is complete, make firm extension on the hand, inclining it in the direction of the ulnar border, and direct the patient to allow the hand to remain in that position. At the end of a week loosen the wrist strip sufficiently to grasp the fractured point with the thumb and fingers, make gentle motion of the carpus, and then tighten the strips; repeat this motion every three or four days.

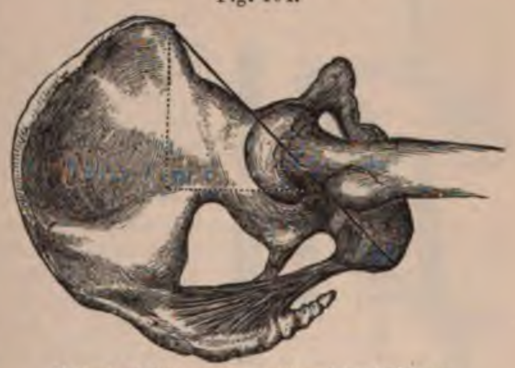
The radius and ulna fractured must be maintained in parallelism. Take two wooden splints of the length of the forearm, nearly or quite the width of the limb at its widest part, properly padded; apply them evenly to the palmar and dorsal surfaces, and retain them with two adhesive strips applied directly around the limb and splints, one at the upper and the other at the lower end.

BONES OF THE LOWER EXTREMITY.

The femur may be fractured through its neck, intra- or extracapsular, in its shaft, at the condyles, and between the condyles. Fracture of the neck may be impacted or separated. If impacted, the foot will incline outward; the shortening will be slight and yet apparent; the head will rotate in the acetabulum, and there will be flexion at the knee. The treatment should be perfect rest of the head of the bone. Crepitus should not be sought for, as it is of the greatest importance that the impaction should be maintained. In cases of doubt, when there is only eversion and slight shortening, it is better to regard the injury as one of impacted fracture and treat it as such. If the separation is complete, the eversion is more marked, shortening may reach an inch and a half or more, and when traction and rotation are made crepitus is obtained.

It is often difficult to determine whether the trochanter is displaced upward, and two tests may be applied: 1. The black line drawn from the anterior superior spine to the most prominent point of the tuberosity of the ischium[1] should pass over the upper extremity of the trochanter, in place, the limb being straight (Fig. 104). 2. The patient being recumbent, the dotted lines drawn from the anterior superior spine directly backwards, and the second from the top of the trochanter directly upwards to the first line, make with the black line a right angle triangle, ilio femoral triangle, when the trochanter is in proper position.[2] A comparison of the base line with that obtained by the same measurement on the opposite side indicates the amount of shortening.

Fig. 104.



Methods of determining position of head of femur.

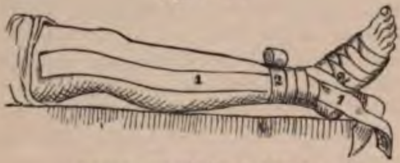
Fractures of the shaft are generally oblique, and the fragments override from half an inch to two inches, owing to the contraction of the muscles; fractures just above the condyles are in most cases oblique from above downwards, and from behind forwards. All of these forms of fracture can be treated more successfully in the straight than in the flexed position, and in nearly all cases extension is more effectually made by the weight and pulley than by any other method. The sooner the limb is put up and subjected to this method of treatment after the fracture, the better; suffering is prevented, and the sufferer made comfortable from the outset.[1] Precisely the same form of apparatus is not suited to all fractures of the femur, but certain modifications are required to meet all of the indications present. In an ordinary case, provide a firm bed with a suitable mattress; apply a roller bandage from the toes to the ankle; next apply strips of strong adhesive plaster two and a half inches broad, and well warmed, to each side of the leg, extending from the fracture some inches below the sole of the foot (Fig. 105); warm the ends and lap them over each other so as to make a loop of two thicknesses four inches below the sole of the foot; in this loop put a piece of wood four inches long and three inches wide; continue the roller bandage over the limb to the groin; pass a strong India-rubber band around the foot-piece in the depressions cut on either side, and attach to it a rope, or make a hole in the centre of the block, through which a cord is passed and a knot tied so that it cannot escape; at the foot-board arrange a pulley on a level with the long axis of the leg; this pulley may be iron or wood, or even a large spool, and may be fastened on the foot-board of the bed, or in an iron or wood upright (Fig. 106); the weights may be obtained in sets and neatly adjusted to the rope, or they may be common smoothing irons or bricks. If it is an impacted fracture of the neck, use a weight not exceeding six pounds; apply a binder about the hips, and maintain the foot erect by sand bags. If the fracture is complete use fifteen, twenty, or more pounds until the shortening is overcome, keeping the foot erect by supporting the leg. If the fracture is in the shaft, apply coaptating splints, which may consist of several narrow strips of thin board properly padded and of such length as to extend well above and below the fracture; or four sole-leather splints may be used which do not quite touch at their margins, the external and internal embracing the condyles; maintain these splints by four to six strips of bandage knotted over the front splint, or by straps with buckles. The amount of weight to be employed must be determined by the resistance to be overcome, and the toleration of the patient; the maximum is about twenty-two pounds,

---

[1] E. Nélaton.

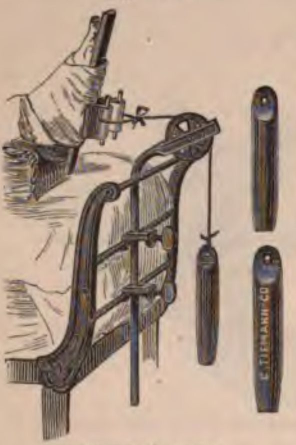
[2] T. Bryant.

Fig. 105.[2]



Application of adhesive strips.

Fig. 106.[3]



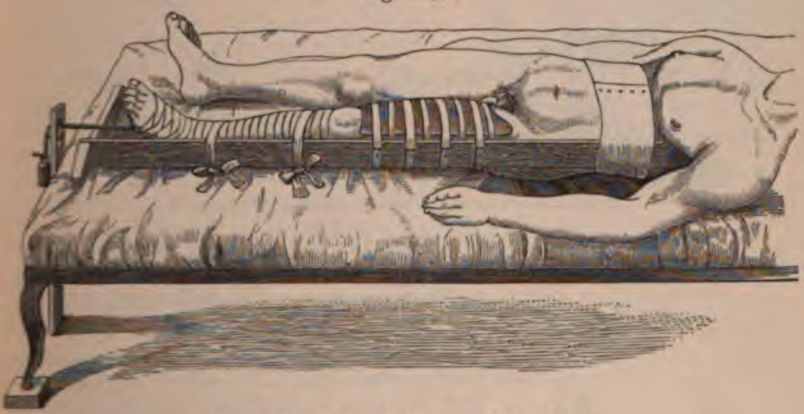
Pulley and weights.

---

[1] F. H. Hamilton. [2] A. Crosby. [3] G. Buck.

and generally not over twenty pounds can be long endured. Counter extension is made by the weight of the body, increased, if necessary, by raising the foot of the bed on blocks, or by a perineal band attached to the head of the bed; apply a long side splint, padded, having a transverse piece at the foot. The appearance of the limb dressed is seen in Fig. 107. Eight weeks is the usual time which a fracture of the thigh in an adult ought to remain in apparatus, but the extension may be lessened when the bones seem firm, and passive motion should be given to the knee-joint as early as the fifth or sixth week; the amount of shortening in adults, when overlapping continues, ranges from one-fourth to one and a half inches.[2]

Fig. 107.



Complete apparatus for fracture of the thigh.[1]

The gypsum bandage should be employed only by those familiar with its use, and in a position to guard carefully against the dangers of too great compression.

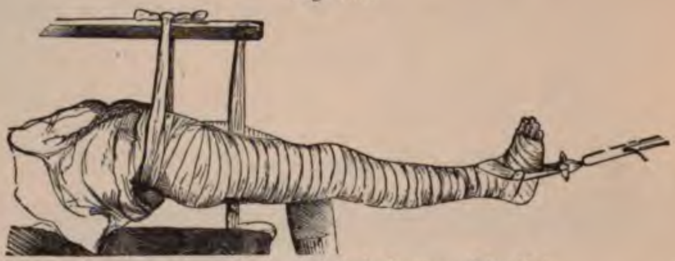
It is applied as follows: Place the patient with his nates overhanging one corner of a table, or with his body, shoulders, and head resting upon a mattress elevated by blankets about one foot from the table, but terminating about two feet from its lower end (Fig. 108); press the perineum against an iron stanchion, screwed upon the lower end of the table, and wound with heavy flannel cloth; suspend the nates by a sling passed under the small of the back and supported by a wooden bar projecting horizontally from the top of the stanchion to some point of support of equal elevation beyond the head; attach compound pulleys to the foot, and give the anæsthetic; the patient being fully under the influence of the anæsthetic, make traction upon the pulleys until the shortening is overcome and the fracture reduced; the direction of the extension must be in the line of the axis of the body; envelop the limb with a dry bandage, cotton batting, or old blanket, cut to fit, or drawers, and protect especially the groin and gluteal fold from excoriation; apply the bandages, saturated with plaster, over the whole limb, from below upwards, including the pelvis; occasionally reinforce the successive turns of the roller by broad pieces of flannel or of patent lint, dipped in the fluid plaster; the number and thickness of the successive layers must be determined by the apparent necessities of the case, generally four or five layers of roller being required, at least upon the thigh; the dressing being completed, continue the extension fifteen or twenty minutes, until the plaster has become hard; on the second or third day after the reduction of the fracture, the patient is allowed to move about on crutches.

---

[1] F. H. Hamilton.

[2] Resolve of the Am. Med. Assoc.

Fig. 108.

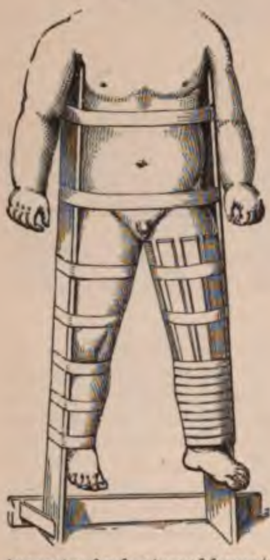


Apparatus of plaster-of-Paris for fracture of the thigh.

Fracture of the femur in children has been treated successfully by laying the limb on the side after reduction.[1] It is better however to apply apparatus. The following method secures good results (Fig. 109):—

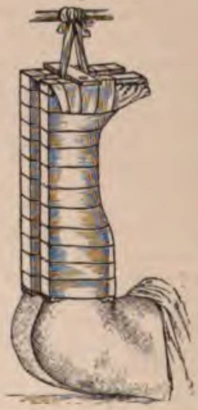
Provide two long narrow side splints extending from near the axillæ below the feet; connect them by a cross piece at the lower ends so that they are a little more widely separated below than above,

Fig. 109.



Apparatus for fracture of femur in children.[2]

Fig. 110.



Position with limbs suspended.[3]

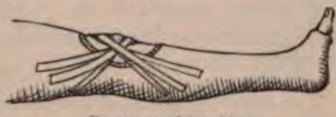
to render the perineum accessible; place them upon each side of the body; secure the leg of the broken limb to the splint with a roller, and fasten the remainder of the limb, the opposite limb, and the body to the splint with broad and separate strips of cloth; the coaptation splint may be made of binders' board; it is of great importance to confine both limbs, for as long as one is free it is almost impossible to secure any degree of quiet; the extended position is much to be preferred to the flexed.

[1] Sir J. Paget. [2] F. H. Hamilton. [3] T. Bryant.

Suspension of the limbs is advisable in very restless children. Adhesive strips are applied to both limbs, and suitably bandaged. Foot pieces are secured by the adhesive strips, and a cross piece is fastened to them by which suspension is maintained (Fig. 110). The child soon becomes accustomed to the position, and remains throughout the treatment fixed in this dressing.

The patella fractured transversely is effectually retained in position by the gypsum bandage (Fig. 111). Envelop the limb from the toes to the groin with sheet cotton or nicely fitting blanketing; apply the gypsum bandage from the toes to the groin, three thicknesses; when the dressing is hard, cut out a large fenestrum exposing the patella and adjacent parts; now apply strips of adhesive plaster over the lower fragment, the centre of each resting on the patella, and the ends extending upward and fastening to the splint; these strips should overlap each other one-third from below upwards; when the lower fragment is firmly fixed, apply strips in a similar manner to the upper fragment, forcing it downward; it is well to apply a last plaster directly over the centre of the patella, to prevent the broken surfaces from tilting upwards. Uniting the fragments of the patella by wire suture[1] has recently been revived.[2]

Fig. 111.



Fracture of patella.

The results of the operation are as follows:[3] Total cases, 182; recent, 81; old, 53; results, good, 75; fair, 35; poor, 24; suppuration, 34; amputation, 4; deaths, 11; partial ankylosis, 17; total ankylosis, 14; not known, 31; under treatment, 3.

The operation is rendered safe only by the strictest compliance with the details of antiseptic treatment of wounds. The conditions which justify the operation, and make it undoubtedly necessary are: 1. Compound fractures of the patella. 2. Old fractures with ligamentous attachments of fragments so lengthened or weakened as to render the limb feeble or useless. In fracture followed by collections of blood in the joint, the operation may prove useful, as it enables the operator to remove from the joint all effusions which might interfere with the union of the bones. In simple fracture without complication, wiring the fragments gives no better results, so far as relates to the usefulness of the limb, than the judicious employment of apparatus. The operation is as follows: The necessary preparation and cleansing having been made, make an incision directly over the line of fracture, the limb being straight, from one condyle to the other; wash out the joint with the irrigator, charged with bichloride solution, 1.2000; remove from the fractured surfaces all clots of blood, or other matter, by means of forceps or the spoon; with the drill insert from one to three wire sutures, passing the drill obliquely from below upwards, and from above downwards, so as not to include the under surface. The wires having been placed in position, insert two short drains, one on either side, through openings made at points lower than the angles of the wound; now twist the wires firmly, cut them off, and turn the free ends into the space between the fragments of the patella; suture such portions of the capsule as can be approximated with catgut, and close the external wound with the continuous suture. The irrigation must continue freely until the wound is closed; thickly sprinkle the surface with iodoform. The external dressing is an iodoform pad around the joint, the bichloride gauze bandage wet with the solution over this, then a layer of absorbent cotton, and finally the gypsum bandage from the ankle to the hip. The drain tubes should be removed on the fourth day, and the first change of dressings, if there are no indications otherwise, in about two weeks. Passive motion should be begun at the first change of dressings, and persistently followed up after five weeks.

---

[1] J. R. Barton. [2] J. Lister. [3] J. A. Cutter.

The following method[1] is often adopted: Elevate the limb upon a well-cushioned inclined plane, in which is cut a deep notch about four inches below the knee; the foot piece is at right angles with the inclined plane, and not at right angles with the horizontal floor, and perforated with holes for the passage of tapes or bandages to secure the foot. Having covered the apparatus with a soft and thick cushion carefully adapted to all the irregularities of the thigh and leg, take especial care to fill the space under the knee; lay the whole limb upon it, and secure the foot gently to the foot-board, between which and the foot place another cushion; the body of the patient should also be flexed upon the thigh, so as the more effectually to relax the quadriceps femoris muscle. Now place a compress made of folded cotton cloth, wide enough to cover the whole breadth of the knee, and long enough to extend from a point four inches above the patella to the tuberosity of the tibia, and one-quarter of an inch thick, on the front of and above the knee. While an assistant presses down the upper fragment of the patella, secure it in place with bands of adhesive plaster; each band should be two to two and a half inches wide, and sufficiently long to inclose the limb and splint obliquely; lay the centre of the first band upon the compress, partly above and partly upon the upper fragment, and bring its extremities down so as to pass through the two notches on the side of the splint, and close upon each other underneath; let the second band, imbricating the first, descend a little lower upon the patella, and secure it below in the same manner; the third, and so on successively until the whole is covered, after which apply a roller from the foot to the groin.

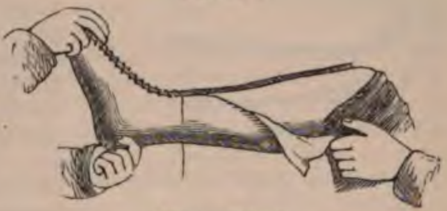
The leg should not be flexed freely under three months.[1]

The tibia is very little displaced, when broken alone, and requires only a leather splint,[2] or a properly adjusted plastic dressing. A very neat and simple plastic dressing may also be made with flannel, plaster-of-Paris, and shellac,[3] prepared and applied as follows: After replacing the fragments as accurately as possible, extension being maintained by assistants, bandage the limb smoothly with a flannel bandage, prepared in the form of an ordinary roller; now soak a flannel bandage spread with dry plaster-of-Paris, and rolled in warm water, adding about two fluidounces of saturated solution of sulphate of potassium, and apply to the limb, over the bandage, by circular and reversed turns; one layer of the flannel applied in this way is amply sufficient for support; the splints should be varnished with shellac. To inspect the point of fracture, the dressing, which is only about an eighth of an inch thick, is easily cut through.

[1] T. Bryant. [2] F. H. Hamilton. [3] G. Wackerhagen.

To avoid the difficulty in removing plaster-of-Paris dressings when applied by the roller bandage to the leg, the following method of dressing is very convenient:[1] Take a woollen or cotton stocking sufficiently long to reach the knee-joint, and cut from it as a pattern six layers of coarse red flannel, one-quarter of inch larger to allow for shrinkage; soak the flannel in water, press and lay over the back of a chair, ready for use; sew a one-quarter inch cotton rope to the posterior median line of the stocking (Fig. 112); the plaster-of-Paris being in process of preparation; cut the stocking in the anterior median line, apply it to the fractured limb, lace up in front, including the rope, extension and counter-extension being kept up by assistants; adjust the fracture; saturate each layer of the flannel now separately in the plaster paste, and apply three layers to each side of the limb, being careful to avoid covering the rope; after this is done, apply a layer of plaster paste to the flannel, and, when this has become sufficiently dry, a coating of shellac varnish, which produces an elegant finish, and also gives firmness to the splints; the varnish will dry in about fifteen minutes. Remove by loosening the rope from the plaster and cutting the thread which binds it to the stocking; cut the plain stocking surface with an ordinary pair of scissors.

Fig. 112.

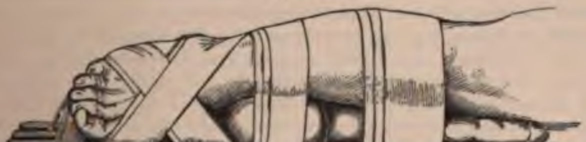


Fracture of tibia.

The fibula is most frequently fractured two or three inches above the lower end; the most convenient dressing is the gypsum, which must include the foot, except the toes; the fracture must be reduced and the foot held firmly in position until the limb is dressed and the material is hardened.

A useful dressing, frequently applied, is constructed as follows (Fig. 113):[2] Select a board, about four inches wide, of sufficient length to extend from the condyle of the femur to two or three inches beyond the foot; upon this place a long triangular pad, the thickest portion of the triangle corresponding to a point about an inch above the internal malleolus; the splint, with the pad resting upon it, lying along the inside of the leg, is secured by roller bandage or adhesive plaster, which must not cover the site of the fracture..

Fig. 113.



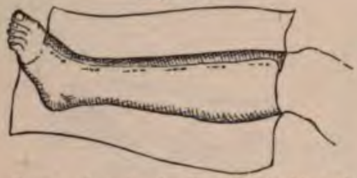
Fracture of fibula.

The tibia and fibula are usually fractured in the lower third. Apply a gypsum dressing[3] made as follows: Select two pieces of flannel, suited to the length and circumference of the limb, and cut them so as to overlap slightly in front, when they resemble the leg of a stocking opened vertically; lay one over the other, and stitch them together from top to bottom down the middle line, like two pieces of note paper stitched at the fold; spread them out under the limb so that the line of stitching corresponds to the back of the calf; bring the two inner folds together, over the shin (Fig. 114), and fasten them by long pins or by stitches; while the leg is held firmly in position, mix the plaster with about an equal bulk of water, and rapidly apply it, partly with a spoon and partly by pouring it over the outer surface of flannel covering the limb; quickly bring the two portions of the second layer over so as to meet, and smooth them with the hand, so as to remove the inequalities in the distribution of the plaster before it hardens; the gypsum sets in about three minutes, incasing the limb in a strong, rigid covering. To take the dressing off, open it like the leaves of a book; its edges must be trimmed, and the pins removed; maintain it in position afterwards by straps with buckles or a very firm bandage. This fracture may also be treated by leather splints, one on either side, extending from above the knee to near the tarso-phalangeal articulations. The apparatus must more or less completely envelop the limb. Sole leather cut so as nearly to inclose the limb, then softened in warm water and moulded to the leg, makes a firm dressing when it becomes dry.

---

[1] G. Wackerhagen. [2] Dupuytren. [3] Bavarian.

Fig. 114.



Gypsum dressing for fracture of tibia and fibula.

A very simple gypsum splint may be made and applied as follows:[1] Select a piece of house flannel, or an old, thin, shrunk blanket, or any suitable substitute; shape the pieces by measurement, taking the circumference of the limb below the knee, at the biggest part of the calf, just above the ankle-joint, from the front of the ankle-joint round the heel to the front again, and at the middle of the metatarsus; the flannel of each splint should be in width half an inch less than half the circumference at any of those points; the width of the two splints should be one inch less than the circumference of the limb at any corresponding part, and long enough to extend from the tubercle of the tibia to the middle of the metatarsus four pieces are required, two for each splint; prepare two bandages of common muslin, each five to six yards long and two inches and a half in width; mix about a handful of good dry plaster with water to the consistence of thick cream; lay the inside pieces of flannel on the table or bed, the outer surface being upwards; soak the outside pieces in the plaster separately, and lay them out on their respective inside pieces. Whilst traction is kept up, and the ends of the broken bones are maintained in apposition, the splints are to be applied and smoothed; then the bandage is to be put on; traction is to be maintained during the hardening of the plaster; next the limb should be laid on a large soft pillow, the toes directed upwards, and the knee a little bent; in the application of the bandage great caution should be observed that it is not drawn tightly anywhere, and that no one turn of the bandage is tighter than another; the two splints should not meet by about half an inch either down the front or back; the intervals are spanned by the dry, porous muslin; at the sides the bandage is fixed to the splints by the plaster, which oozes into it from the outer layer of flannel; if it becomes necessary next day, or later, to ease the splints, or to inspect the limb at any spot, the bandage can be slit up with scissors along the middle line in front. They are hinged together at the back by the muslin bandage which spans the interval there. These splints are characterized by their simplicity, stability, and economy, and therefore commend themselves strongly to the country practitioner; the surgeon can take out with him, to his case, a bag of plaster-of-Paris, and the muslin bandages, and perhaps the flannel; the plaster should be good, but need not be the very best; must be dry, and should be kept, when in store, in a dry, warm place; be cautious in using any flannel which has not been in some way shrunk.

---

[1] J. Croft.

II. COMPOUND FRACTURES.

A fracture is compound when it communicates through a wound with the external air. These injuries have always been regarded as dangerous, because such wounds commonly inflame and suppurate, but, as it is now possible to protect them from the action of septic ferments, recovery will occur without suppuration. They may be produced by external objects penetrating to the bone, and causing both the wound of the soft parts and the fracture, as projectiles, or the fracture may at first be subcutaneous, and by the continued action of the force one fragment may be driven through the skin, thus making the fracture compound.

Projectiles[1] cause a variety of compound fractures, viz: (1) removal of a portion of bone; (2) splintering off of fragments of the external cylindrical part of a bone; (3) making a hole throughout the entire substance of the bone; (4) driving the external cylinder into the cancellated structure. These fractures are always serious injuries, as they frequently involve the question of resection and amputation, and are always liable to dangerous complications, as hemorrhage, tetanus, septicæmia, and pyæmia. The first question to determine is as to the possibility of saving the limb, and, as a rule, the attempt should be made if the injury to the soft parts is not very great; if the bone does not largely protrude, and the skin is not extensively lacerated; if the continued warmth of the limb below the fracture indicate the escape of the main artery, and that the nerves are not implicated. The thorough use of disinfectants, by which putrefactive suppuration is now prevented, adds largely to our means of saving limbs after compound fractures.

Scarcely any amount or form of fractured bone alone would justify the immediate resort to the knife if taken singly, even supposing the bone fractured extensively into a large joint; for in such a case, although anchylosis of the joint would probably occur, it would prove a lesser evil than that of amputation.[2] Superadded to a compound or comminuted fracture of bone, the injury may be rendered yet more serious by extensive laceration of muscles. In considering this latter condition much will depend on the kind of laceration of the muscles—whether they were merely cut asunder or whether contused or torn, and whether this injury involves a few or the majority of the muscles of the limb. We examine with great care the condition of the vessels. Is the main trunk whole, we should ask, as in fracture of the thigh or leg? What is the condition of the nerves? Does sensibility extend to the toes or fingers? If the evidence of the integrity of both artery and nerve fail, and the sinking temperature of the limb and the loss of sensibility continue to increase, we have no alternative but amputation.

---

[1] T. Longmore.

[2] F. C. Skey.

If it is decided to save the limb, the first indication, in a recent case, is to convert the compound into a simple fracture, as when the opening is very slight and readily closed. Cleanse the skin with soap and water, shave off all hairs; wash the surface and the wound with bichloride solution, and close the wound with prepared catgut suture, placing in the dependent angle a catgut drain; sprinkle iodoform over the wound, and apply iodoform gauze external dressing. If the bone protrude and is not readily reduced, cleanse the skin as directed, and proceed to enlarge the wound under irrigation with bichloride solution; if necessary, saw off such projecting portions as will enable the fragments to be nicely adjusted. Remove from the wound all foreign matter, as a projectile, dirt, loose fragments; if blood is effused from ruptured veins, open the spaces where it is collected and with the finger, handle of the scalpel, or spoon, remove all clots. In order to maintain the fragments in proper apposition it is better to wire them together as follows: With the small bone-drill insert one or more wire sutures, and twist them to a requisite degree of firmness; cut the wires about one-fourth of an inch from the bone and turn the end downward into the space between the bones with strong forceps.

Compound fractures are the wounds in which aseptic treatment was first applied, and in which excellent results can be obtained. In purifying the wound great pains must be taken; dirt must be carefully removed; all blood clots ought to be turned out as completely as possible; the ends of the bones are cleaned, and if they cannot be returned or got to fit, portions should be sawn off; the ends may be tied together with a silver wire.[1]

In closing the wound first suture with catgut all the deeper structures, and continue the irrigation.

It is frequently possible to suture deep structures in the wound, as divided fascia, and this should always be done so as to bring all parts into such apposition as will promote healing.

Finally, close the external wound with the antiseptic sutures, applying a drain at the most depending point; complete the dressing with iodoform gauze, extending well over the limb, and over all apply two or three layers of plaster-of-Paris roller to give immobility to the fracture.

The plaster-of-Paris dressing should include the nearest joints in order to insure immobility.[2]

If a rubber drain is used, cut down through the dressings, on the third day, at the point where it is, remove it, and apply iodoform gauze.

BONES OF THE FACE.

The superior maxilla has such relations to the structure of the face that every effort should be made to preserve its symmetry in compound fractures, and when caused by projectiles. Unless the fragments are either completely detached or but slightly adherent, they should not be taken away, but be replaced with care, as in time consolidation may take place, and very little permanent deformity be left; irrigate with bichloride solutions, and, after careful adjustment of the movable fragments, close the wound with horsehair sutures and apply iodoform dressings; if fragments subsequently loosen, remove them.[1] Bony union of these fragments usually takes place with great facility.[2]

---

[1] W. W. Cheyne.

[2] J. E. Erichsen.

The inferior maxilla, fractured by projectiles, is with difficulty retained in position. The fragments should be preserved and adjusted with wire, and efforts made to retain them in apposition by the four-tailed bandage, with pasteboard cap for the jaw, and interdental splints of gutta-percha.[2]

BONES OF THE UPPER EXTREMITY.

The clavicle is in such relations with the pleural cavity and the larger vessels of the neck that serious complications frequently attend compound and shot fractures of that bone. In the treatment of uncomplicated fractures, remove detached splinters immediately, and necrosed fragments at the earliest practical moment;[3] then cautiously wire together the fragments, being careful not to penetrate the under surface of the bone.

The humerus should always be subjected to conservative treatment, unless extremely injured by a massive projectile, or longitudinal comminution exist to a great extent, or a joint is also involved, or, finally, the patient's health is unfavorable.[4] In cases which admit of conservative treatment, proceed as follows: If the bone is much splintered, extend the wound if necessary for exploration and operation, at the most depending opening if there are two wounds, or make a fresh incision if only one exists and it is not in a favorable position; make an examination with the finger for any foreign body or detached pieces of bone, and remove them; remove also such partially detached portions and fragments as are retained only by very slight and narrow periosteal connections, and saw or cut off sharp points of projecting spicula;[4] wire together whatever fragments require it. Dress the wound with iodoform gauze, and support the limb by a fenestrated splint of gypsum, or sole leather, or other material capable of being moulded to it, and which will secure rest. Immobility is securely obtained by a triangular cushion[5] and axillary pad interposed between the thorax and the arm.

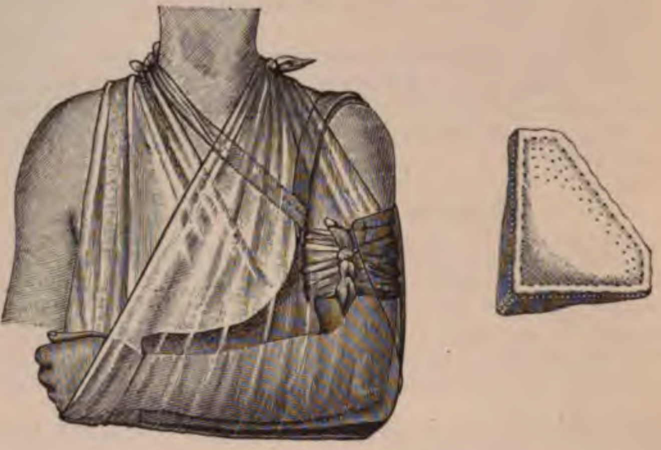
This useful appliance consists of a three-cornered cushion, with rounded edges, made of horsehair, upholstered with soft material, and inclosed with waterproof material. It is applied as follows: One of the rounded edges is placed in the axilla, and is then fixed by a bandage, attached behind and in front by safety-needles, and passed over the opposite or healthy shoulder; the fractured arm is then laid upon the cushion, and both are maintained in position by a broad sling; the wound is now dressed with a Scultetus bandage, the edges of the sling being drawn back for that purpose. (Fig. 115.)

The radius and ulna, like the humerus, should be conservatively treated unless there is partial ablation by a cannon ball, or comminution of both bones with laceration of the bloodvessels and nerves, or extensive comminution in the vicinity of joints, with fissures extending into the articulations.[2] After extracting loose fragments, if no considerable deformity exists, only simple splints and bandages are required; if there is great tendency to displacement, the fenestrated gypsum dressing, applied when the arm is midway between pronation and supination, with a slightly bent elbow, is most useful.[3] If but a single bone is fractured, the most simple splint dressing is required.

---

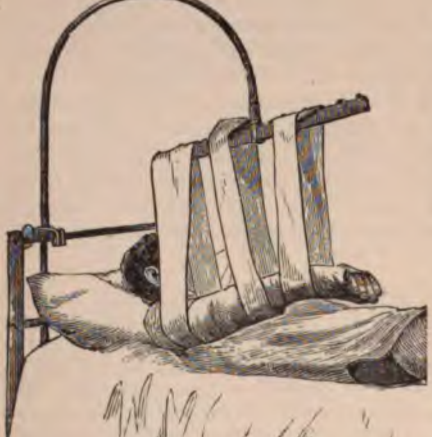
[1] J. J. Chisholm.
[2] F. H. Hamilton.
[3] G. A. Otis.
[4] T. Longmore.
[5] F. Stromeyer.

Fig. 115.



Stromeyer's cushion pad.[1]

Fig. 116.



Suspension apparatus.

Suspension of the forearm in the early stages of treatment is very important, and may be effected by simple apparatus, as follows (Fig. 116):[4] Select iron tubing, or other material, fasten its upright portion by clamps at the head of the bedstead, while its lower portion overhangs the bed and holds suspended at its extremity a flattened strip of hard wood, on the upper edge of which a row of screw heads serves for fastening the ends of the canvas bands that suspend the limb; the strip of wood that supports the limb should play horizontally on a swivel joint at the extremity of the iron tubing.

---

[1] F. Esmarch.

[2] F. Swartz.

[3] H. Fischer.

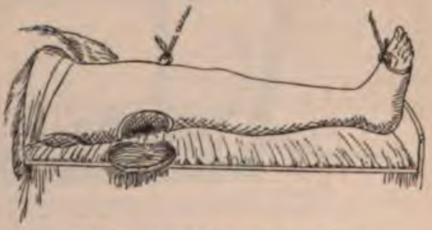
[4] G. Buck.

The metacarpal and phalangeal bones should, as far as practicable, be preserved, whatever the nature of the injury, though their functions may subsequently be greatly limited. Their wounds are extremely painful and troublesome in management, but are not specially liable to induce tetanus.[1] In the treatment, splinters and foreign bodies should first be removed; free incisions[1] through the aponeurotic layers are important in preventing accumulations of matter under fasciæ and tendons, or relieving tension caused by such collections. Iodoform gauze dressings pressed into the wounds in ordinary cases, and the hot water in those liable to extensive sloughs, should be early resorted to and persistently used; the hand may be supported upon properly adapted splints.

BONES OF THE LOWER EXTREMITY.

The femur, fractured by a modern rifle-ball, is generally extensively comminuted, and often fissured for long distances along the shaft; an attempt to conserve the injured limb, however free from complications, and however favorable the case may appear to be, will unavoidably subject the patient to a wide variety of hazardous circumstances, owing to the prolonged treatment and attendant difficulties which must necessarily occur before a cure can be completed.[2] If the femoral artery and vein have been divided, any attempt to save the limb will certainly prove fatal. In shot fractures of the upper third of the femur, especially if it be doubtful whether the hip-joint is implicated or not, the question is still open whether excision of the injured portion, or removal of the detached fragments and relying on the natural efforts for union, or amputation, which is very dangerous, is best for the safety of the patient. The decision must depend upon the extent of the injury to the surrounding structures, the condition of the patient, and other circumstances in each individual case. As a rule, in shot fractures in the middle and lower third of the thigh, amputation is not now a necessary measure. When it is determined to attempt to save the limb, the wound may be enlarged to remove spicula of bone, and occasionally counter-openings should be made to permit the more thorough drainage of the wound; bichloride solutions should be injected into all the recesses, and iodoform cotton introduced with forceps to avoid creating additional irritation. Constant irrigation of the entire wound by carbolic acid, 1.100, the limb being suspended, may at first be employed. The

Fig. 117.



Gypsum splint for fracture of femur.

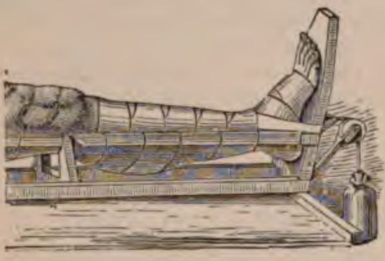
---

[1] G. A. Otis.

[2] T. Longmore.

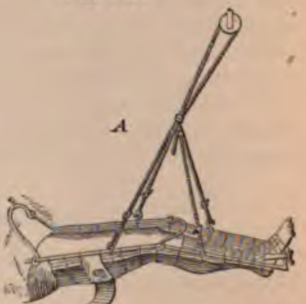
part should always be perfectly immobilized by apparatus; for this purpose the splint should allow the limb to be swung so as to admit of dressing without change of position. The gypsum splints or fenestrated gypsum bandage may be employed (Fig. 117), or the cradle with a suitable weight at the foot (Fig. 118). A wire suspending apparatus[1] (Fig. 119) has given good results.

Fig. 118.



Wooden frame.

Fig. 119.



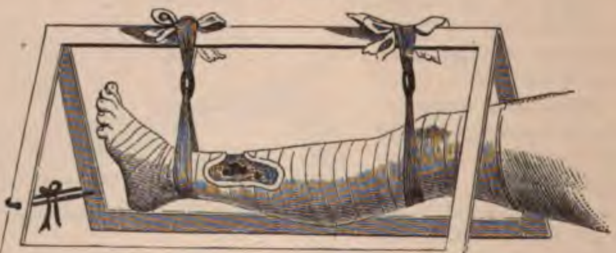
Wire suspension apparatus.

The frame is stout wire; strips of cloth are laid across the splint from side to side, and upon these the limb is laid; the centre and upper extremity of the splint are kept asunder by strong bows of iron wire, so arranged that they can be put on or taken off without disturbing the dressings; when applied the inside wire must be bent upwards at its upper extremity, so as to make room for the pubes; extension is made by adhesive plasters, and the whole apparatus is finally suspended to the ceiling, or to some point above, by a rope or pulley.

If the bones are not readily retained in position they should be wired. Extension with a weight, as in the treatment of simple fracture, is necessary if the apparatus does not retain the bones in apposition (Fig. 118.)

The tibia and fibula, fractured without implication of the knee or ankle-joints, are very amenable to conservative measures, and hence, as a general rule, ordinary fractures below the knee, from

Fig. 120.



Suspension of leg.

---

[1] J. T. Hodgen.

rifle-balls, should never cause primary amputation.[1] The treatment should be the same as that given for compound fractures in general. The plaster apparatus should be used, and the limb swung in a frame, with proper fenestra for dressing the wounds.

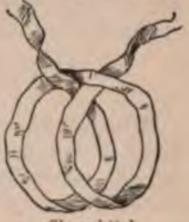
A very simple apparatus may be made (Fig. 120), consisting of a wooden frame formed of four square bars of the length of the lower extremity, two on either side of the leg.

CHAPTER XVI.

DISLOCATION OF BONES.

A BONE is dislocated when it is displaced from another at the place of natural articulation; there may be no other injury than rupture of the capsule, simple dislocation, or there may be a wound of the integument entering the joint, compound dislocation. The signs of dislocation are, preternatural immobility, and tendency, when reduced, to remain; but with free motion without crepitus. The treatment required is immediate reduction; anæsthetics must be used for relaxation; when reduction is possible by manipulation this method should always be preferred; if more force is necessary, make extension and counter-extension with the hands, aided with bandages tied in the form of the clove-hitch (Fig. 121); if more power is required, resort to mechanical contrivances, as the pulley. Compound dislocations are among the most serious accidents which can befall a limb;[2] but it must be borne in mind that by the proper use of antiseptic dressings these injuries may now be treated without suppuration, and are therefore far more amenable to conservative measures than formerly. The treatment must depend upon the amount of injury in each case; if slight, reduction may be effected by suitable enlargement of the wound, followed by thorough cleansing and disinfection; resection should be made when the bones are destroyed, the antiseptic dressings being employed; amputation will be necessary when the principal artery of the limb is ruptured, or there is destruction of the tissues about the joint, or the patient is old or feeble

Fig. 121.



Clove-hitch.

BONES OF THE FACE.

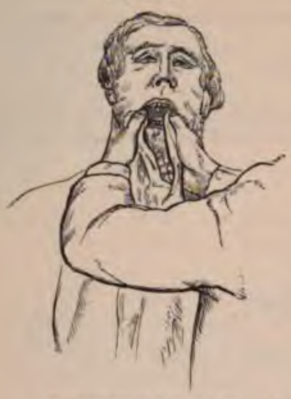
The temporo-maxillary joints are dislocated by the displacement of the condyles of the lower jaw forwards, one or both, the latter being more frequent. Reduce as follows: The patient seated on the floor with the head between the knees of the operator, place a couple of pieces of cork, gutta-percha, or pine wood as far back be-

---

[1] J. T. Hodgen.

[2] T. Bryant.

Fig. 122.



Reduction of lower jaw.

tween the molars as possible; now draw the chin steadily upwards, taking care not to draw it forward at the same time. Or, sitting or standing in front, depress the condyles by means of the thumbs protected by pieces of leather placed on the tops of the molars, or a fold of cloth (Fig. 122). If this method fail, reduce one side at a time, or give an anæsthetic; after reduction support the jaw with a bandage.

BONES OF THE VERTEBRÆ.

The vertebral articulations are rarely displaced without fracture, especially in the lumbar and dorsal regions. In the cervical region forward and backward luxations may occur with or without fracture. Reduction should always be attempted. If the lumbar or dorsal vertebræ are displaced make forcible extension with judicious lateral motion and direct pressure upon the spine. If a cervical vertebra is displaced raise the head firmly by the chin and occiput, and if reduction does not follow, add slight rotation in the direction of dislocation to disengage the process, or pláce the patient on the back and make extension in the same manner.

BONES OF THE UPPER EXTREMITY.

The sterno-clavicular joint may be dislocated by the displacement of the end of the clavicle forwards, upwards, or backwards. Reduction is effected by elevating the shoulder in pushing upward at the elbow, or by drawing the shoulders backward and upward with the knee pressing against the spine between the scapula. Though frequently it is difficult to retain the clavicle in position, the function of the arm is rarely impaired. For the first and second forms the pad in the axilla, the sling for the elbow, and a pad upon the displaced bone, retained by adhesive straps, are most useful; for the third form, rest on the back, or such appliance as will retain the shoulder upwards and outwards, are required.

The acromio-clavicular joint may be luxated by the upward or downward displacement of the end of the clavicle; reduction is effected by drawing the shoulder outward and backward. The retaining apparatus for the upward luxation should be applied as follows:[1] Place a compress over the articulation, and retain it by two strips of adhesive plaster, the edges being glued to the skin by collodion; bandage the hand and forearm with a flannel roller; apply a loop of elastic bandage[2] five feet long and one inch and a half wide, passed under the elbow of the injured side; draw the ends snugly over the compress, carrying the anterior one around the axilla of the sound side, as in a spica of the shoulder, to join the other between the clavicles, where they are fastened with strong pins. Complete and permanent restoration rarely follows any treatment.[1]

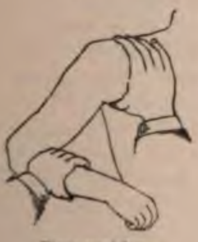
---

[1] W. T. Bull.

[2] H. A. Martin.

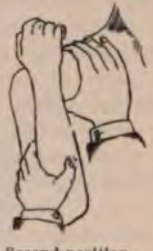
The shoulder joint dislocations consist of the displacement of the head of the humerus; first, downwards into the axilla; second, forwards under the coracoid process; and third, backwards under the spine of the scapula. The reliable sign of these displacements is the projection of the elbow from the chest when the hand of the dislocated arm is placed upon the opposite shoulder. The method of reduction in the first two varieties is the same; proceed as follows: Flex the forearm upon the arm, and while the arm is elevated to a right angle with the trunk, rotate gently forwards by depressing the hand and forearm; or place the knee in the axilla to press the head outward and serve as a fulcrum, and use the shaft as a lever; or laying the patient down, place the heel against a pad in the axilla, and grasping the wrist and elbow, make steady traction, meanwhile prying the head outward with the heel; failing, give an anæsthetic.[1] Reduction may also be effected by manipulation: grasp the shoulder with one hand and the flexed elbow with the other, make extension at the elbow, drawing it from the side (Fig. 123) with slight rotatory motion outwards; when extension is fully made, raise the elbow and with the arm describe a semicircle towards the sternum and face, then suddenly depress the elbow upon the thorax, rotating the head of the humerus inwards, and with the thumb of the right hand giving proper direction to the head (Fig. 124); this manœuvre may be repeated if necessary.[3] In the subspinous form make extension towards the joint, or resort to the last method, standing behind the patient and drawing the elbow backward and rotating the bone, while the thumb of the right hand guides the head to the joint.

Fig. 123.[2]



First position.

Fig. 124.



Second position.

Or, let the operator[4] place the injured arm at right angles to the body, and standing against it, with his side to the patient and his hip pressed firmly, but not roughly, into the axilla, fold the arm and hand of the patient closely round his pelvis, and fix the hand firmly by pressing it against the crest of his ilium; reduction is effected merely by a rotation, or version, of the surgeon's body, with a force and rapidity which necessarily vary with the peculiarity of the dislocation—some yielding most readily to a sudden and powerful effort, and others to gentle and gradually increasing traction.

---

[1] F. H. Hamilton. [2] T. Bryant. [3] H. H. Smith. [4] J. E. Kelly.

In compound dislocations the question as to reduction or resection should be decided as follows: In a healthy patient, without complications, reduction is preferable; but if the patient is weak or old, or the exposed bone is badly injured, or the parts are much lacerated, saw off the exposed head of the bone.[1] Antiseptic dressings should be scrupulously applied.

The elbow-joint may be dislocated by displacement of the ulna and radius backwards, forwards, inwards, outwards, the last two being partial. Examine carefully to determine whether there is a tranverse fracture of the humerus, or of one condyle, or of the olecranon. Reduce the first form thus: the patient seated in a chair, press the knee in the bend of the elbow and flex the arm forcibly but slowly around it.[2] Other methods are as follows: The patient being seated, carry the arm and forearm directly backwards, the scapula being pressed forwards;[3] extension of the forearm from the hand or wrist downwards;[4] extension of the forearm from its middle by an assistant, while the surgeon seizes upon the olecranon process with the fingers of one hand, and placing the palm of the other against the front and upper part of the forearm pulls forcibly backwards.[5] The second form may be reduced by forced flexion aided by pressure; the lateral displacements are restored by moderate extension combined with lateral pressure.[6] The head of the radius may be displaced separately forwards, outwards, and backwards, the first being far the most frequent; reduction is effected in all forms by extension aided by pressure upon the head of the radius made in the right direction.[6] In compound dislocations in healthy patients, reduce the bones and close the wound antiseptically, unless there is much comminution, when excision of the bones involved should be performed; in general, a useful limb results from these excisions of the joint surfaces.

The wrist-joint is luxated by displacement of the carpus forwards or backwards; reduction is made by extension in a straight line with slight rocking or lateral motions if necessary.[6]

The phalangeal joints may be dislocated and are generally easily reduced. The displacement of the first phalanx of the thumb upon its metacarpal bone is an exception; the difficulty of reduction is due to the escape of the head of the metacarpal bone between the two tendons of the flexor brevis, where it is lodged as in a button-hole.[7] Reduction is effected by first pressing the metacarpal bone firmly to the centre of the palm to relax the short flexor, then putting the displaced phalanx in a state of extreme extension to relax the tissues of the button-hole and to push up those which form its distal part over the projecting head of the metacarpal bone; this is done by dragging the hyper-extended thumb downwards or away from the wrist, and then acute flexion will restore it to its place.[8] If this method fail, with a very narrow-bladed tenotome divide the insertions of the flexor tendon and repeat the manœuvre.

---

[1] T. Holmes.

[2] Sir A. Cooper; F. H. Hamilton.

[3] R. Liston, J. Miller.

[4] F. C. Skey.

[5] J. Pirre.

[6] F. H. Hamilton.

[7] Fabbri.

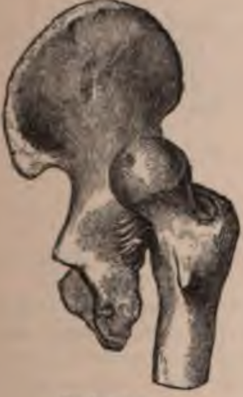
[8] T. Holmes.

BONES OF THE LOWER EXTREMITY.

The hip-joint dislocations are the most important which the surgeon encounters, and hence demand the most careful study.

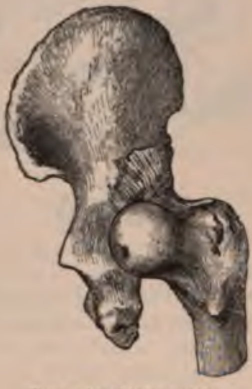
The hip-joint[1] is protected and strengthened by the ilio-femoral, or inverted **Y**-ligament, which is inserted above into the front and outside of the inferior spinous process of the ilium, and below into the anterior intertrochanteric line; it has two main branches, extending, the outer to the trochanter major, and the inner to the trochanter minor; in regular dislocations this ligament is unbroken and controls largely the movements of the head of the femur.

Fig. 125.



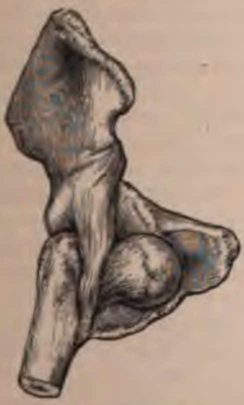
On dorsum.

Fig. 126.



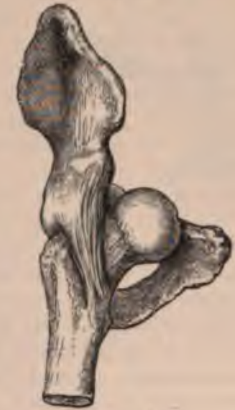
Toward ischiatic notch.

Fig. 127.



Into foramen ovale.

Fig. 128.



Upon pubes.

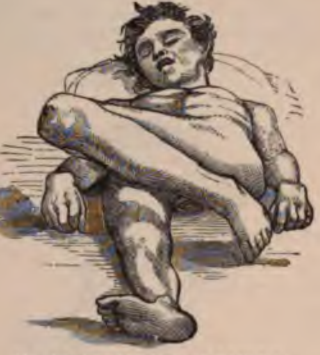
The several positions of the head of the bone with reference to the socket are conveniently classified as follows: 1, upward and backward on the dorsum ilii (Fig. 125); 2, backward toward the ischiatic notch (Fig. 126); 3, downward and inward into the foramen ovale (Fig. 127); 4, upward and forward upon the pubes (Fig. 128).

---

[1] H. J. Bigelow.

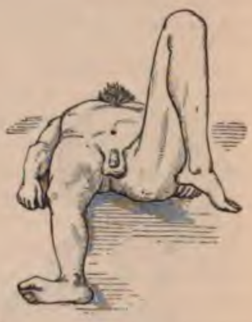
There are some variations in these positions which the surgeon should fully appreciate, viz: 1. The dislocation may be outwards (Fig. 129), the head lying below the tendon of the obturator internus.[1] 2. The head may pass directly downward and rest on the lower margin of the acetabulum (Fig. 130).[1] 3. The head may pass into the perineum and lie behind the scrotum (Fig. 131). Though the head of the bone may be primarily luxated in various directions, yet the downward dislocation is by far the most common, as the capsule is thin and weak at this part, and flexion, by which the ligament is relaxed, with adduction or abduction, is the habitual attitude of the thigh in action and self-defence. From this position the head of the bone readily passes to the dorsal, or thyroid, or pubic regions; thus all regular dislocations may be secondary. These several positions are sufficiently well recognized for reduction by the following sign, namely: the head of the femur always faces the same way as the internal condyle. Reduction may be effected by rotation, by lifting, or by apparatus; the two former methods are to be preferred and should always be first intelligently and perseveringly carried out; if, finally, they prove unsuccessful, apparatus must be applied. The method by rotation is simple and generally successful. Etherize the patient to relaxation, and place him recumbent on the floor. The best general rule for reducing a recent dislocation is to get the head of the femur directly below the socket by flexing the thigh at about a right angle, and then to rotate in

Fig. 129.



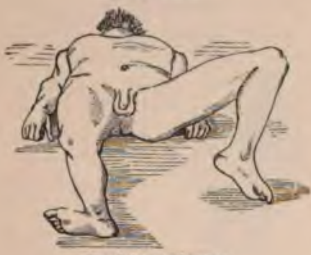
Head below the obturator tendon.

Fig. 130.



Head on lower margin of acetabulum.

Fig. 131.



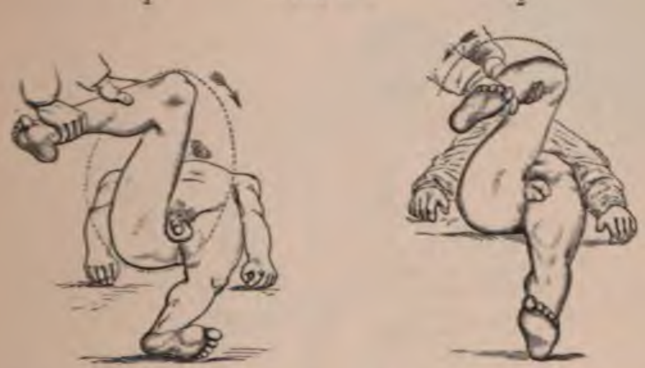
Head in perineum.

---

[1] H. J. Bigelow.

the directions indicated (Fig. 132). This rule applies to all dislocations except the pubic, and even to that when secondary from below the socket. The reduction by the lifting method is usually instantaneous, and flexion is the basis of its success (Fig. 133). If after one or two trials it appears that the bone cannot be lifted into place, enlarge the rent in the capsule a little by moving the flexed thigh from one side to the other so as to sweep the head of the femur across below the socket; and again repeat the act of lifting. The following rules for reduction of the femur from its several positions should be observed: (1) In dorsal dislocations, flex and forcibly lift; if this effort fail, flex and lift while abducting. If this fail, it will be found that abduction has carried the head of the bone from the dorsum nearly or quite to the thyroid foramen, and that the capsular rent has been so enlarged that the first method may now prove successful. (2) In thyroid dislocations, adduction of the flexed thigh reverses this movement and carries the head from the thyroid foramen to the dorsum, and also enlarges the opening, making the first rule effective. (3) The pubic dislocations may generally be brought down without difficulty from above the socket, after flexion, especially if they are secondary, and may then be reduced from that position like the thyroid.

Fig. 132.



Reduction by manipulation.—1. In dislocation into the foramen ovale. 2. In ilio-sciatic notch.

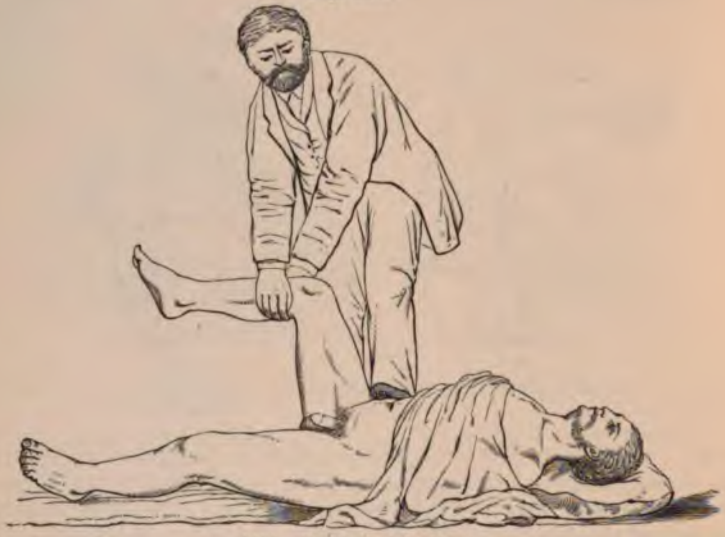
The flexion relaxes the ilio-femoral ligament, and the relaxation may be further increased by slight adduction; then rotate very slightly inwards; that is to say, move the foot away from the middle line while the knee is held steady; this disengages the head from behind the socket; slight traction in the line of the femur will then usually bring the bone into position; if more force is required, the surgeon may place his foot, covered only with a stocking, on the anterior superior spinous process, to steady the pelvis while he raises the bent knee (Fig. 133).

Another method[1] of lifting is to fix the patient in the recumbent position by straps or bandages around the hips and the board on which he lies; the thigh being bent at right angles with the body, the surgeon stands astride the leg, facing the patient; stooping and passing his arms under the leg near the knee, the leg is brought against his perineum, and he is able to lift to great advantage (Fig. 134).

---

[1] J. E. Kelly.

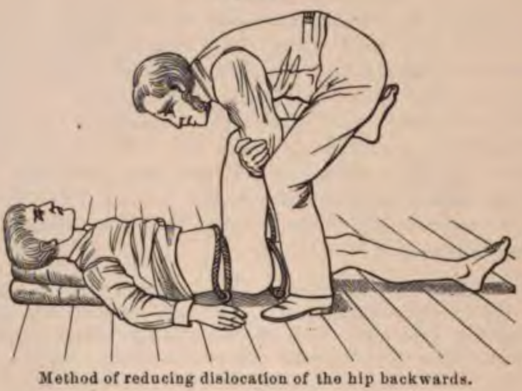
Fig. 133.



Lifting the head of the bone.

A fulcrum made by rolling one or more sheets into a firm band, two or three inches in diameter, may aid the manipulator. Place the centre of the band in the groin, the patient lying on the opposite side, and while assistants raise the ends, by pressure at the knees, the head is lifted into the socket; the same result is secured by requiring an assistant to lift the head of the bone by means of a stout sheet in the groin and over his shoulders.[1]

Fig. 134.



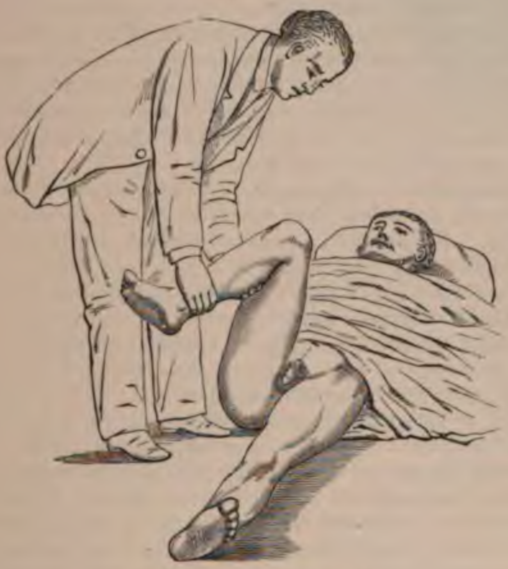
Method of reducing dislocation of the hip backwards.

---

[1] G. Sutton.

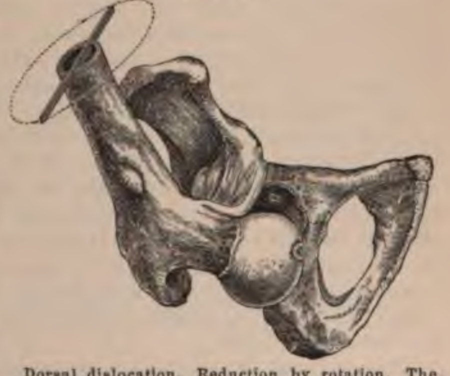
Reduction may be attempted without an anæsthetic. In dorsal dislocations proceed as follows: Hand upon the injured side and grasp the ankle with one hand and the knee in the other (Fig. 135); steadily flex the thigh upon the abdomen, slightly adducting so that the head of the bone is lifted out from behind the acetabulum and the ilio-femoral ligament relaxed; now slowly abduct, and finally rotate outwards by bringing the foot of the injured leg over the sound leg. By this manœuvre the head is made to revolve around the great trochanter, which is fixed by the outer branch of the Y-ligament, and to rise into its articular cavity (Fig. 136); finally, bring the limb down parallel with the other. The rule may be, lift up, bend out, roll out.[2] Backward displacement is reduced by the

Fig. 135.



Reduction by manipulation.[1]

Fig. 136.



Dorsal dislocation. Reduction by rotation. The limb has been flexed and abducted, and it remains only to rotate it outwards, and so to render the outer branch of the Y-ligament tense.

---

[1] J. E. Erichsen.

[2] H. J. Bigelow.

same rotations. In downward dislocation the movement is the reverse of that for dorsal displacements. In dislocation on the pubes semiflex the thigh so as to relax the ilio-femoral ligament and to bring the head down from the pubes; abduct and rotate inwards to disengage it completely; finally, while rotating outwards and drawing on the thigh, carry the knee inwards and downwards to its place by the side of its fellow.[1] Reduction of dislocations at the hip by apparatus, now very seldom employed, requires the compound pulleys for extension, the counter-extension being made by a perineal band fastened to a firm object above the head of the patient. The direction of extension will readily be understood in each case.

The knee-joint is dislocated by displacement of the tibia backwards, forwards, outwards, and inwards, but in general the luxation is incomplete. Reduction is generally effected without much difficulty. If backwards, use forced and extreme flexion; if forward, reverse the movement; if lateral, make extension and pressure.

The patella may be displaced outwards, inwards, or on its own axis; reduction is made by laying the patient on the floor, lifting the heel and depressing the knee, so as to relax completely the quadriceps muscle, and pushing the patella into position. If this effort fails in the last form, flex the thigh and straighten the leg while pressure is made on the patella.[2] Anæsthesia greatly aids reduction.

The ankle-joint is luxated by the displacement of the tibia forwards and backwards. Reduction is effected by extension and counter-extension combined with pressure. Division of the tendo Achillis has been found necessary in cases of backward luxation. Dislocation outwards or inwards is a rotation of the astragalus, accompanied usually with a fracture of the fibula and rupture of the internal lateral ligament.[3] Compound dislocations are not infrequent at the ankle-joint, and always demand the most judicious care; as in other compound dislocations the conditions present must determine the course of procedure. By conservative measures in young and healthy persons, where the vessels have escaped damage, and there are no other serious complications, the limb and joint may often be saved. The wound should be cleansed of all foreign matters, bichloride solutions, 1 to 1000, should be injected into all its recesses, proper drains and iodoform gauze strips pressed into them and applied externally. The joint must be immobilized by the fenestrated gypsum bandage, unless there is great swelling, when the splint must be used. Anchylosis will ensue, but the increased mobility of the transverse tarsal joint will in a great measure compensate for this loss.[4] When there is much comminution removal of the fragments is necessary, or excision of the joint may be required, followed by the dressings already given. In a certain proportion of cases, the injury, or health, or age of the patient, renders amputation the only safe course.

The tarsal bones may be luxated from their positions, but generally the great violence which causes such displacement does severe injury to the tarsus. Luxations of the astragalus are far the most important; the dislocations of this bone may be forwards, backwards, outwards, and inwards, or it may be rotated on its axis. As a rule, if the dislocation is simple, attempt immediate reduction; if the luxation is complete and reduction impossible, resect; if the luxation is compound, resect if there is severe laceration, or other injuries complicating these conditions, or amputate. Reduction is effected by extension from the foot, grasped as in removing a boot, and counter-extension from the knee, with such pressure upon the displaced bone as may be required. If the astragalus is displaced from the scaphoid and calcaneum, the treatment is the same.

---

[1] H. J. Bigelow.

[2] G. Sutton.

[3] F. H. Hamilton.

[4] T. Holmes.

CHAPTER XVII.

DISEASES OF BONE AND SPECIAL OPERATIONS.

MORBID ANATOMY illustrates physiological processes very markedly in the osseous system; in every case some analogy at least may be discovered between the morbid phenomena and a normal prototype; in many cases there is a simple excess or deficiency of normal growth, but in the larger number there is a predominant activity of single anatomical factors whose part in normal growth is more subordinate.[1] In the examination as to the condition of bone, much useful information may be obtained in obscure cases, both as to the seat and nature of the disease, by percussion;[2] the instrument used should be a metallic hammer with a whalebone handle, and the bone should be firmly compressed on two sides; of the more noticeable sounds elicited by percussion of diseased bone are a high pitch when the bone is very compact, as in osteo-sclerosis, and a hollow sound when the bone is very porous, as in osteo-porosis.

I. RICKETS.

The swellings and distortions of rickets depend on a morbid acceleration of those changes which usher in and prepare the way for the transformation of cartilage into bone, and the development of bone from periosteum; ossification follows at a slower pace, and hence the substance which should undergo immediate conversion into bone-tissue accumulates, forms swellings, and allows the bones to be bent and broken.[1]

In its various forms rickets[3] is a very common affection in children from six months to two years of age, who live in damp, dark, ill-ventilated apartments and have insufficient or improper food. Faulty digestion results in the development of acids, mainly lactic, in the blood, and the rapid elimination of the phosphates by the kidneys. The child grows feeble, peevish, melancholy, has perspiration of the head; the ends of the long bones, radius, tibia, and ribs enlarge, and those bones subjected to pressure bend.

---

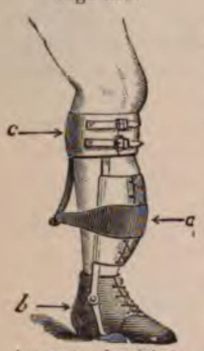
[1] E. Rindfleisch.

[2] Lücke.

[3] J. L. Smith.

The general treatment is (1) fresh air and sunlight; (2) cod-liver oil, and syrup of iodide of iron, or the compound syrup of the phosphates. The mechanical treatment consists in supporting the bones which are inclined to curve during the period of softening; the greatest care and discretion are required to avoid doing harm by undue pressure on yielding bones; as far as possible the weight of the body should be taken from the long bones, and when curvature occurs gentle lateral support should be given by well-padded splints, making such points of pressure as will not involve other bones. Plastic apparatus may be applied to support a weak spinal column and the lower extremities. The curvature of the lower limbs may be very firmly supported by apparatus which protects the bones without other pressure. If curvature exists, much may be accomplished in straightening the limb of the child that does not walk, by firm pressure and extension with the hands, repeated several times daily. When the child is walking an apparatus may be adjusted to the tibia (Fig. 137), but little benefit will be experienced farther than the prevention of greater deformity.

Fig. 137.



Apparatus for rickets.

Two upright steel stems are fastened below to a shoe and terminated above in the calf-band; a leather bandage is passed around the stems and tightly laced in front over the arc of the curvature (*a*), or a strap is passed over the arc of the curvature and fastened to a spur suspended from the calf-band behind (*c*); the points of resistance being in either case the heel of the shoe (*b*) and the posterior trough of the calf-band (*c*).

When the bones of the leg and thigh are both bent, the apparatus must be so constructed as to overcome the deformity which takes different directions.

The support is given by double stems of steel, secured to a shoe, carried up as high as the thigh and jointed at the ankle and knee to allow the patient perfect freedom of motion; they are kept in place by calf and thigh bands. The bow is corrected by pads being placed respectively against the ankle and knee on the concave side of the limb, whilst a strap passed around on the highest point of the arc, inside of the outer stem, tightly buttoned to the steel bar on the concave side, gradually compels the leg to become parallel with it; in slight cases, or when the bow is greatest below the calf, an instrument carried up to the knee is sufficient.

When the bones have become consolidated in deformed positions which impair function, they must be straightened by osteoclasis or osteotomy.

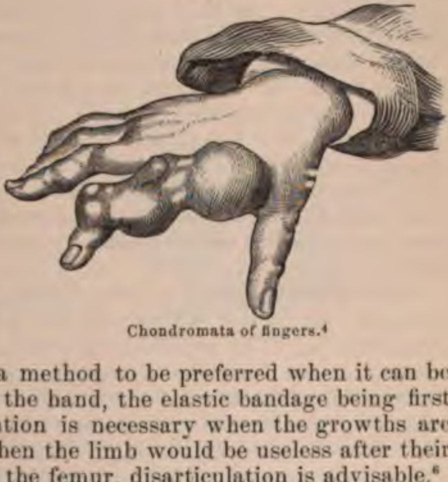
II. TUMORS OF BONE.

Osseous tumors are distinguished from other ossifying tumors by the uniform production of true bone as an essential element in their development.[1] They are never formed altogether of bone, but there is always present an ossifying matrix, derived generally from the periosteum and cartilage; the amount of periosteum, cartilage, and bone present varies indefinitely in different cases.[1] In the diagnosis,[2] general smoothness of surface is usually significant of a tumor growing within a bone and expanding it, unless in the case of cartilaginous tumors, which, after growing within bones, have protruded through some of their expanded walls; pulsation in a non-cancerous tumor connected with bone is a nearly certain sign of growth within bone, except in the case of myeloid epulis; if these means of diagnosis are insufficient, resort to puncture or an exploratory incision. In operations for the removal of tumors of bone, the following general rules[3] should be borne in mind: (1) Simply removing a tumor from the place in which it lies is as sufficient for the cure of one growing in a bone as for that of one growing in connective tissue; (2) it is rarely necessary to disturb the continuity of a bone in order to remove from it any innocent tumor; (3) the safety of removing a tumor from within a bone is greater than that of any resection or amputation that might have been performed as an alternative operation; (4) innocent tumors growing on bones should be removed by excision, and growing in bones by enucleation; (5) cancerous and recurrent tumors should generally be removed by amputation or wide excision.

---

[1] R. Virchow.

Fig. 138.



Chondromata of fingers.[4]

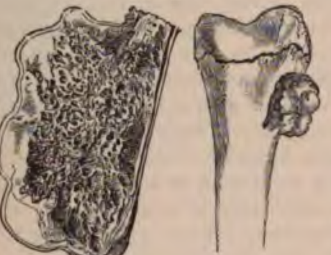
Chondromata, cartilage tumors, are usually seated in the bones; the phalanges of the fingers (Fig. 138) and toes are more often affected; next, the humerus, femur, and tibia; next, the jaws, pelvic bones, and scapula; they may spring from the periosteum and from the medulla; new bone may form, layer after layer, producing a bony capsule which may continue for a long time.[3] They are of slow growth, painless, rounded, nodular, and when very large prone to ulcerate. The treatment is removal when life is not endangered by the operation. Enucleation[2] is a method to be preferred when it can be effected, as in the bones of the hand, the elastic bandage being first applied to the limb; amputation is necessary when the growths are multiple or very large, or when the limb would be useless after their removal;[5] if the tumor is in the femur, disarticulation is advisable.[6]

Exostoses are manifestations of an increased physiological activity of the periosteum; in the majority of cases some general disease, as syphilis, rheumatism, or rickets, has a part in their causation, though an injury is often the assigned cause.[3] They frequently occur in the multiple or diffuse form. They may consist of (1) spongy bone-sub-

---

[1] R. Moxon.
[2] Sir J. Paget.
[3] E. Rindfleisch.
[4] T. Bryant.
[5] T. Holmes.
[6] T. Billroth.

Fig. 139.



Exostosis.

stance, which occurs almost exclusively on the epiphyses of the long bones (Fig. 139), outgrowths from the epiphyseal cartilages, but from the first being intimately connected with the spongy substance of the epiphyses; (2) compact bony substance, ivory-like, which develops on the bones of the face, skull, pelvis, scapula, great toe; (3) ossification of tendons, fascia, and muscles, where they are attached to bone. These tumors form without pain, and are inconvenient when in the vicinity of joints or on the toe, and unsightly when on the face or head. The only treatment is excision, which is neither advisable nor necessary, unless the impairment of function be so great as to balance an operation dangerous to the joint and to life, for these tumors in time cease to grow. On epiphyseal exostoses mucous bursæ are often found, usually communicating with the joint, which are liable to be opened and lead to unfortunate results.[1] These growths do not return when removed.[2] When they appear on the great toe the phalanx should be amputated. The ivory exostoses of the skull owing to their hardness are generally excised with extreme difficulty by means of saw and chisel, and the violence involves very great danger. As they may exist without other inconvenience than the deformity which they cause, the risk of excision should not be lightly incurred. An exception must be made in the case of ivory exostoses of the orbit, as the gradual growth of such tumors displaces the eye, causing blindness, by stretching the optic nerve, and a hideous squint; the base, usually attached to the inner or outer angle of the root of the orbit, is often small, and when fully exposed can be partially cut with a fine saw, and then broken with the chisel and mallet.[3] Exostoses of the antrum often have very small bases and are removed without difficulty on opening the front wall of the cavity.

Sarcomata comprise two groups, namely, the external and the internal; the former spring from the periosteum and the latter from the medulla. The periosteal growths (Fig. 140) embrace for the most part the hard forms, namely, the fibro, chondro, and osteoid sarcomata; they take their origin from the layer of the periosteum next to the bone, while the external layer often remains as a fibrous investment which, by its unyielding character, retards the growth; the cortical portion of the bone is not at first involved, and if very thick, as in the diaphysis of long bones, it may become only superficially affected, but if the tumor appear where spongy bone is near the surface, as in the epiphyses of long bones, the growth spreads into the medullary spaces and it is difficult to distinguish periosteal from medullary sarcomata.[4] They are quite malignant[1] and usually contain all the varieties of sarcoma tissue, but the spindle cell-tissue predominates in most cases, especially in those enormous tumors which are developed on the ends of the great bones of the extremities.[1] The medullary form, myeloid tumor,[2] myelogenic osteo-sarcomata,[3] appear especially in the jaws, as epulis;[4] next in the tibia, radius, and ulna; these tumors often contain mucous cysts and spherical or branched osseous formations, circumscribed nodules mostly forming in the medullary cavity, which gradually destroy the bone; but new bone is constantly developed from the periosteum, so that the tumor, if very large, often remains covered, entirely or partially, by a shell of bone, which appears puffed up like a bladder (Fig. 141); in the lower extremity they become very vascular; small traumatic aneurisms develop in them with the true aneurismal murmur; cysts also develop in them; they are usually solitary, rarely generally infectious; they appear in the jaws at the second dentition, and in the long bones at middle age.[6] When the growth is periosteal it resembles the fibrous tumor, but the sarcoma is softer, more elastic, and vascular; when within bone it is difficult to distinguish sarcoma from other innocent tumors. It differs from cancer chiefly in that it is of slower growth, has a broadly rounded shape, and its seat is in the articular end rather than in the shaft of a bone, and in the absence of glandular disease and of all cachexia, though three or four years may have elapsed.[2] Excision is the only available remedy, and should be resorted to without delay, the base being thoroughly removed.[2]

---

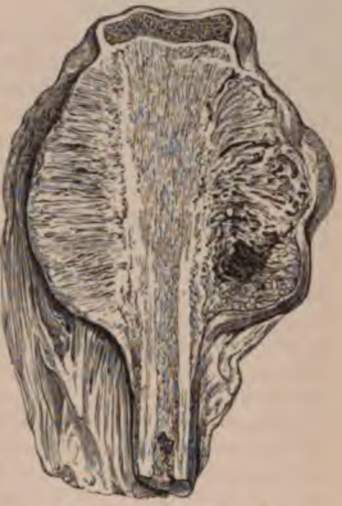
[1] T. Billroth.

[2] E. Rinfleisch.

[3] T. Holmes.

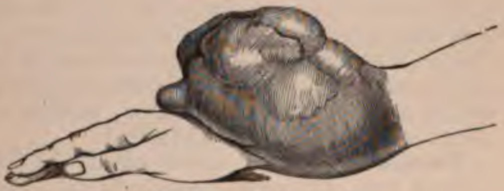
[4] R. Virchow.

Fig. 140.



Periosteal osteo-sarcoma.[5]

Fig. 141.



Myeloid tumor of radius.[7]

Fibromata[6] springing from the periosteum are quite frequent, and are generally composed of fibres and spindle-shaped cells; the latter may preponderate, giving the growth the character of a fibro-sarcoma; the periosteum of the bones of the skull and face, especially the inferior turbinated bones, is particularly liable to this disease; in the latter position the tumors appear as naso-pharyngeal polypi; these tumors may form in the interior of bone, especially in the upper jaw; they are most common in the young, but after puberty. They are hard, round, of slow growth, and without pain. The treatment is removal by enucleation.

---

[1] E. Rindfleisch. [2] Sir J. Paget. [3] R. Virchow. [4] E. Nélaton.
[5] T. Bryant. [6] T. Billroth. [7] J. E. Erichsen.

Carcinomata occurring in bone may originate by a propagation of the infiltration from cutaneous, mucous, or glandular cancers; but cancer apparently also appears originally in bone, though it may have an epithelial origin, as in case of those soft and quickly growing cancers which spring from the upper end of the humerus and femur, at one time from the medulla and at another from the periosteum.[1] It may assume various forms, namely, encephaloid, which is most common, scirrhus, and epithelial. The diagnosis[2] in obscure cases must be made in favor of cancer; (1) when the tumor commences growth before puberty or after middle age, unless it is a cartilaginous or bony tumor on a finger or toe, or near an articulation; (2) when the tumor on or in a bone has doubled, or more than doubled, its size in six months, and is not inflamed; (3) if, in addition to rapid growth, the veins over the tumor have much enlarged, or the tumor has protruded far through ulcerated openings, bleeds, and discharges matter; (4) if, though the tumor is not inflamed, the neighboring lymph glands are also enlarged; (5) if the patient has lost weight and strength out of proportion to the damage to health by pain or fever or other accident of the tumor; (6) if situated on the shaft of any bone but a phalanx. The treatment of all forms of cancer of bone must be by amputation when the disease is local; the point selected must be as far as it may be safe to operate from the seat of the malignant growth.[2]

III. INFLAMMATION OF BONE.

The morbid changes included under the term inflammation of bone are remarkable for their clinical diversity and singular anatomical uniformity; there is no deviation from the physiological type, except where pus forms, which introduces infinite complications into the whole course of the inflammatory process, as repair can be brought about only by circuitous methods.[1]

Periostitis, acute, occurs chiefly in young persons, and in its typical forms almost exclusively in the long bones, as the femur and tibia; at first there is high fever, not unfrequently a chill, severe pain in the affected part; swelling without redness; skin tense and usually œdematous; every touch or jar is very painful. The inflammation may resolve at this stage, or progress to suppuration, when additional symptoms appear: the swelling now increases, the skin becomes reddish, then brownish-red, the œdema extends, the neighboring joint becomes painful and swells, and towards the twelfth day fluctuation is detected.[3] The inflammation often occurs in the periosteum of the third phalanx (felon), causing great suffering, and terminating in necrosis. In the early stage of the disease in the long bones apply the strong tinct. iodine, and repeat when the vesicles dry up;[3] add ice, if, when applied until the deeper parts are cold, it is agreeable and the pain subsides. When effusion takes place and is confined beneath the dense fibrous periosteal layer, free incision down to the bone gives immediate relief; as the object is to relieve tension, the incision should be made as soon as this condition clearly exists, though pus may not have formed; this practice is especially important when the upper part of the shaft or the articular end of a bone is affected.[1] The local applications should now be soothing, as fomentations; and carbolized solutions should be freely used in the wound to arrest septic changes. Pus should be freely evacuated wherever it may be found, and free drainage secured by position or drains. The general treatment should consist of anodynes, with laxatives and low diet, to relieve pain and inflammation; and tonics and nutritious food when suppuration is established.

---

[1] E. Rindfleisch. [2] Sir J. Paget. [3] T. Billroth.

Osteo-myelitis, acute, is an inflammation of the medulla of bones; it occurs in the young and is generally caused by injury; the symptoms are, intense aching pain at the seat of inflammation which is relieved only by perforation of the bone; swelling, which begins as a puffiness but has a peculiarly abrupt margin, and as the disease spreads advances up the limb; red and hepatized appearance of the marrow, seen in the bone of a stump; globules of oil mixed with the pus discharged; irritative fever with great restlessness, and in bad cases delirium.[2] The symptoms so closely resemble those of suppurative periostitis that in many cases it cannot be discovered whether only the periosteum is affected or the medulla also; but if while there is great pain and fever, or complete inability to move the limb on account of pain, swelling does not occur for several days, it is to be inferred that the seat of the inflammation is the medullary cavity.[3] The inflammation may induce acute periosteal abscess, thrombosis, pyæmia, necrosis, and the separation of the epiphysis by the suppuration of the epiphyseal cartilage.

The question of exploration with a view to reach and destroy the source of infection should be early considered. It is now possible by dissection, and, perhaps, trephining, to expose the diseased bone tissue, remove the detritus, and disinfect with bichloride solutions without endangering the patient, and with immediate relief to all of the symptoms. Delay in meeting these indications will almost certainly be followed by septicæmia, pyæmia, and death.

IV. CARIES OF BONE.

Periostitis and osteo-myelitis may terminate in circumscribed suppuration, which results in ulceration or caries of bone.

Superficial caries corresponds to an indolent ulcer of the skin; the surface of bone exhibits a loss of substance which gradually increases in depth, but remains shallow, and continually throws off small quantities of pus and shreds of decaying structures, derived from the denuded medullary tissue, which at a certain depth is in a state of hyperæmic proliferation, passing near the surface into an exceedingly dense corpuscular infiltration; the cells occupy all the pores of the bone tissue and leave no room for blood or bloodvessels, which are finally converted, with the cells, into molecular débris.[1] The symptoms are tenderness, œdema, severe boring and tearing pains at night.[2] The process of cure consists in the detachment and removal of the necrosed portion or particles of bone, cessation of the process of proliferation, shrinking together of the interstitial granulation tissue, and its transformation into cicatricial tissue.[2] The indications as to general treatment are the improvement of the health by tonics and hygienic measures; the local treatment is: (1) Removal of the purulent débris; (2) arrest of the carious process; (3) healing of the surface. If the caries affects the shaft of a long bone, easily accessible, as the tibia, cleanse and shave the surface, and irrigate with bichloride solution, 1–10000, during the operation; now expose the carious bone by a free incision, whether the pus is still contained in an abscess or is escaping from a sinus; cleanse the exposed surface of all foreign matters; very gently remove, with forceps or periosteal knife or gouge, every particle of dead bone, without injury to the living bone; complete the dressing by packing the wound with iodoform gauze; place the part in a condition of perfect rest, using plastic apparatus if necessary; renew these dressings only when required for cleanliness, and change the application to bals. Peru when granulations cover the bone.

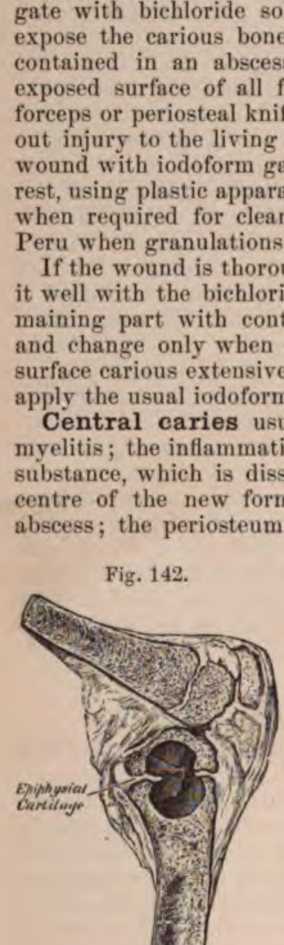
---

[1] T. Bryant. [2] J. A. Lidell. [3] T. Billroth.

If the wound is thoroughly clean and free from septic matter, wash it well with the bichloride solution, adjust a drain and close the remaining part with continuous suture. Apply iodoform dressings and change only when necessary. If the wound is large and the surface carious extensively, pack it with strips of iodoform gauze and apply the usual iodoform dressings.

Central caries usually begins in a hollow bone as an osteomyelitis; the inflammation extends to the inner surface of the cortical substance, which is dissolved, and pus may form quite early in the centre of the new formation, creating what is known as a bone abscess; the periosteum is thickened, new bony deposits form from the surface of the bone, and the hollow bone is thus enlarged externally at the point where the abscess forms, giving it the appearance of inflation; the central caries may be accompanied by partial necrosis of portions of bone on the internal surface of the cortical substance.[2] These bone abscesses more often form in the spongy portion of long bones, especially of the tibia (Fig. 142). The symptoms are very often uncertain, as the chronic inflammation may exist deep in the bone; there may be only a dull pain, with but slight impairment of function; it is only when there is severe pain on pressure and œdema of the skin, showing that the periosteum is involved, that the case becomes more apparent; but it may happen that the true state of the disease can be

Fig. 142.



Abscess in head of tibia.[3]

---

[1] E. Rindfleisch. [2] T. Billroth. [3] T. Bryant.

determined only when perforation has taken place and the probe may be passed into the cavity.[1] The most reliable symptoms, when present, are severe, long continued, and paroxysmal pain and local swelling, often at a single point, where there is extreme tenderness on pressure.[2] The treatment is trephining; mark on the skin the precise spot where the tenderness and pain are located; give an anæsthetic and make a crucial incision down to the bone, raise the periosteum to the requisite extent, and with the trephine open the cavity.[2] If no pus is found, puncture the surrounding bone with a strong awl or drill, for the pus has been found just beside the track of the trephine.[3] The abscess cavity should be cleansed with the scoop and bichloride solution and filled with pledgets of iodoform gauze.

A less severe operation is at times of equal value, namely, puncture with a drill, especially when the seat of the abscess is not well defined.[4] Ignipuncture[5] with the thermo-cautery has been recommended highly. In all cases of chronic ostitis, where fluctuation and sinuses or other indications of points of softening and breaking down do not call for the curette or chisel, and in many cases even after removal of products of softening, the cautery can still be used to advantage to stimulate surrounding bone into a normal activity. Its application may be *intraosteal* or *intracapsular*. If the former, the glowing platinum is either plunged through the skin and soft tissue right down to the bone and into its substance, or else an incision is made through a part, or the whole of the soft parts, since it is not so much disturbance of these latter which is primarily aimed at. Antiseptic precautions and dressings are of course indicated, and if the incision has been a large one it may be partially closed, but ample opportunity must be given for drainage as long as may be necessary. When combined with other operative measures a depot of softening may be cut down upon, its contents removed, the sharp spoon used as indicated, and from this bone cavity the cautery point may be made to perforate in different directions. The bone exposed to intensest heat is burnt into a crust; around this takes place an active inflammation which leads first to an osteo-porosis, and later to an osteo-sclerosis, which means virtual recovery. Intracapsular ignipuncture may be made either with or without previously opening the joint.

Internal and external caries may be accompanied by necrosis and by suppuration or osteo-plastic periostitis in the same hollow bone; abscesses appear at different points; rotten bone and a sequestrum may, at the same time, be felt with a probe; at one point the surface is exposed, and at another the interior; the whole bone is thickened, as is the periosteum; thin pus escapes from the fistulous openings; the surface is thickly covered with porous osteophytes; necrosed portions lie here and there; the medullary cavity is partly filled with porous bony substance, and round holes are found containing necrosed bone.[1] The treatment should be thorough exploration antiseptically of the diseased tissues, and the removal of all dead bone, and the products of inflammation; irrigation of the wound with bichloride solution and iodoform dressings. The disease may be so extensive as to require amputation.

V. NECROSIS OF BONE.

The complete arrest of nutrition in a certain portion of bone, which results in its death, is usually due to suppurative periostitis as a proximate cause, even in traumatic cases, though not an invariable consequence; the pus excites a sequestrating inflammation both in the periosteum and the bone; the former being converted into a pyogenic membrane, is separated from the bone, while a fungating ostitis, fed by the medulla, is set up in the bone, which shuts off the organism by granulation tissue; the dead bone is called the sequestrum, and the fungating ostitis which separates it, demarcation; the detached periosteum develops a layer of new bone immediately under the pyogenic surface, forming a capsule, the involucrum, which incloses the sequestra.[1]

---

[1] T. Billroth.
[2] C. Jackson.
[3] T. Holmes.
[4] T. Bryant.
[5] Richet; Kachet; R. Park.

Partial necrosis of the diaphysis occurs when the outermost layers of the compact substance of bone have been too long cut off from the circulation and nutrition to allow their vitality being restored from the medulla; the fungating ostitis does the work of a sequestrating inflammation, detaching the lamellæ of dead bone and mingling them with the pus which fills the abscess cavity.[1] The presence of dead tissue is recognized when it is exposed by its white appearance, with dark places if it is situated deeply. Only the probe introduced through sinuses can exactly determine its presence; in addition, there is increased thickness due to the new formation of bone. The treatment at first should be limited to keeping the fistulæ clean with antiseptic solutions. Chemical solution of the sequestrum is liable to affect injuriously the new-formed bone, and thus do harm. Mechanical removal of the dead bone is the only proper method, but it is important not to attempt removal until the dead is completely separated from the living bone, for the dead can rarely be detached without removing a good deal of the healthy and of the newly-formed bone, nor is the involucrum firm enough before complete detachment.[2] The complete separation of a superficial sequestrum is generally easily made out with a probe.

Total necrosis of the diaphysis results from suppuration of the periosteum and medulla; the pus from the periosteum perforates the soft tissues and escapes, but that from the medulla falls to detritus or putrefies within the bone; the process of detachment is effected by an interstitial proliferation of granulations in the edges of the living bone by which a slight amount of bone is consumed; the sequestrum now lies loose in a pus cavity; this detachment of thick hollow bones requires months and sometimes more than a year; meantime the periosteum has formed a shell of new bone which in time becomes very thick, and finally compact.[2] The probe is the guide to determine whether the bone is loose, but, it is difficult to decide on the mobility of a large sequestrum, especially when the bone is curved, as the lower jaw; the duration of the process and the thickness of the bony case are important aids; most sequestra are usually detached in eight or ten months, and in a year, even an entire diaphysis usually becomes detached, completely separated from its connections.[2] The treatment is, in general, the same as in partial necrosis; but this distinction must be made, namely, if the formation of bone be still weak, though the sequestrum be already detached, it is well to postpone the extraction in case of the humerus, tibia, and femur, so that the formation

[1] E. Rindfleisch.

[2] T. Billroth.

of bone may be firmer;[1] it may be necessary occasionally to resect when no new bone exists.[2]

VI. SEQUESTROTOMY.

The removal of necrosed bone may be effected by successive slight operations by which the periosteum is gradually separated from the dead mass, the indirect method, or by a single formal operation, the direct method.

The indirect method[3] is to be preferred when the bone is superficial and it is desirable to preserve its contour,[4] as in the removal of large sections of the tibia, the lower and upper jaw, the clavicle. This method consists in separating from time to time the diseased periosteum from the bone beneath with the handle of the scalpel or with a small spatula, the periosteum not being raised beyond the limits of the disease. By this means free escape for pus is constantly maintained, the new-formed bone becomes more perfectly adapted to the space occupied by the old, and the tissue of the new structure is more firm. When at length the sequestrum is separated it is readily raised from its bed with scarcely the appearance of blood, and the shape and function of the bone is largely preserved.

The direct method is often tedious, and much complicated by the oozing of blood into the wound. To avoid bleeding, the vessels of the limb should, as far as practicable, be emptied of their blood. As the elastic bandage, so effectual in removing blood from the limb, would be liable to force infectious matters into the meshes of the cellular tissue, and the extremities of lymphatic vessels, it is better to empty the limb as completely as possible by causing it to be raised high in the air for a few moments, and then apply the elastic bandage or tubing above the point of operation.[5] The operation must be entirely antiseptic.[1] If the opening in the bony case is large, and the sequestrum small, attempt the direct removal with strong forceps through this opening; if this is impracticable, with a stout knife make an incision through the soft parts down to the bony case from one fistulous opening to another; with a periosteotome draw the thickened soft parts from the rough surface of the bony case to just sufficient extent; remove this exposed portion with a saw, or a chisel and hammer, or gnawing forceps; the sequestrum being exposed, attempt its removal by elevators or strong forceps; first move it gently in its case in different directions until free from all spiculæ; if the sequestrum is not detached, avoid forcing it out, but wait a few weeks or months until its separation is complete. After the operation the suppurating cavity is to be packed with strips of iodoform gauze, and covered with iodoform gauze dressings, and the parts maintained in a state of rest; the ossifying granulations fill the cavity slowly, and the fistulæ may remain open for a long period, but the process of closure cannot be hastened unless the walls become sclerosed and cease to granulate, when the application of the hot iron to the cavity, or the chisel to the fistulæ, may be beneficial.

---

[1] T. Billroth.
[2] T. Holmes.
[3] J. R. Wood.
[4] Von Langenbeck.
[5] F. Esmarch.

CHAPTER XVIII.

INJURIES OF JOINTS AND SPECIAL OPERATIONS.

JOINTS are composed of the ends of two bones covered with cartilage; of a sac frequently containing many appendages, pockets, and bulgings; of a synovial membrane, a fibrous capsule, and the strengthening ligaments.[1] It is owing to the intimate relations of these complicated structures that the injuries and diseases of joints are peculiarly serious.

On account of their exposed positions joints are specially liable to wounds of various forms and degrees of severity.

I. CONTUSIONS.

Contusion of a joint may be so severe as to be followed by extravasation of blood into the tissue around it, or even into its cavity. Examine first for a fracture, then apply apparatus to secure perfect rest, and the ice-bag to prevent inflammation; the gypsum dressing with a suitable fenestrum at the joint is the best apparatus for the injury of joints of the lower extremity.

II. WOUNDS.

A punctured wound is dangerous, owing to the tendency to suppurative inflammation and the retention of the pus. That the joint is involved is known by the escape of synovia. Pursue the following treatment: Place the patient in bed, close the wound with collodion or adhesive plaster, if it is slight, but with sutures accurately applied if it gape; secure perfect rest to the joint by immovable apparatus, and if any application is made, use ice. In favorable cases all excitement about the joint will subside in a few days, and when the dressings are removed at the end of four to six weeks recovery will be complete.[1]

An incised wound is also recognized as having penetrated the joint by the appearance of synovia. Such a wound must be treated and dressed antiseptically; close it accurately with sutures, except the entrance of the drainage tube, apply immovable apparatus to the limb, and locally use ice bags; give cooling regimen. If the case proceed favorably, retain antiseptic dressings until union is firm, then commence passive motion, but restrict it for at least one month.

A lacerated wound should be treated as follows: Cleanse the wound of all foreign matters under irrigation with bichloride solution, pare the edges of all contused tissues, insert drainage tubes, and if possible close the wound with catgut sutures and treat it as an incised wound; if it is large, gaping, and cannot be closed, the better method is to enlarge the opening whenever it is necessary to gain free drainage of the cavity of the joint, inject bichloride solution, 1–2000, to destroy septic ferments which may have entered the joint; introduce the drainage tube or a horsehair drain, carbolized; apply iodoform dressings and immobolize the joint by apparatus; renew the dressings as often as necessary and prevent accumulation of secretions in the wound.[1] However favorably the case proceeds, the joint must be retained in a state of perfect rest for at least two weeks, when passive motion may be begun, but if it produce any swelling of the joint or tenderness, all motion must cease for several days, when it may be renewed.

---

[1] T. Billroth.

CHAPTER XIX.

DISEASES OF THE JOINTS AND SPECIAL OPERATIONS.

It may be stated as a general truth that diseases of a joint commence either in the synovial or osseous tissues, and that they originate for the most part in an acute or chronic inflammation; in the progress of any case both tissues may become eventually involved; practically there is no primary disease of articular cartilages, and when they undergo a change it is secondary to some other affection, either of the synovial membrane or of the bone; when the disease commences in the synovial membrane or in the bone, and disorganization of the joint follows, it is in that tissue in which the disease began that the gravest change will be seen.[2]

I. INFLAMMATION.

Injury in some form is generally the cause of inflammation of the joints. The various wounds already mentioned are liable to terminate in inflammation, announced by swelling and heat of the part, pain on pressure, and fever.

Serous synovitis[1] commences with swelling, heat, and pain of the joint, but slight fever; the synovial membrane is slightly swollen and moderately vascular; the cavity is full of serum with synovia, and the remainder of the joint is healthy. The symptoms rapidly subside with rest, painting with the tincture of iodine, or applying compresses of wet bandages, or blisters; the patient soon begins to use the joint without difficulty, the fluid is gradually absorbed and function is restored.

Parenchymatous or purulent synovitis[1] begins with a chill, high fever, extreme tenderness of the joint which is fixed, swollen, and hot; there is no fluctuation, but the whole limb is œde-

[1] T. Billroth.

[2] T. Bryant.

matous; the synovial membrane much swollen, red, and puffy; there is a little flocculent pus in the cavity, and the cartilage looks cloudy; the difference between the serous and purulent varieties is that in the former the synovial membrane is simply stimulated to secretion, while in the latter it is deeply affected. The treatment at this early stage is: (1) fixation of the joint by apparatus, in the most favorable position for subsequent use if anchylosis occur, anæsthetics being given if necessary; the gypsum is generally the most available, the limb being well protected by wadding to avoid strangulation; (2) the continued application of ice-bladders so as to effectually cool the entire joint. Before applying these dressings the parts may be thoroughly painted with tr. iodine. Opium and quinine should be given in such measure as will secure relief from the effects of pain and fever. If the disease subsides months may elapse before the inflammation entirely disappears, and great care is necessary to avoid a renewal of the disease by cold or injury. If the disease continues to progress abscesses form, the joint becomes more swollen, the fever is high, and inter-current chills occur, emaciation follows, with sleeplessness and prostration; in the joint there is a collection of thick yellow pus mixed with fibrinous flocculi, the synovial membrane is covered with dense purulent rinds under which it is very red and puffy, partly ulcerated; the cartilage is partly broken down into pulp, partly necrosed and peels off; the bone is very red or infiltrated metastatic abscess may form in the lungs, liver, or other organs, and death ensue from pyæmia. Occasionally the inflammation extends uncontrollably in and around the joint, the suppuration involving the thigh and leg, followed by great exhaustion, fever and chills. The antiseptic treatment is most serviceable in such cases.[1] The treatment should be prompt and decisive; all abscesses should be opened, cleansed with antiseptic solutions, well drained, and dressed with iodoform dressings. If pus has formed in the joint the cavity must be freely exposed under bichloride irrigations, every particle of matter removed, a suitable drain tube placed in the joint, and iodoform dressings applied. If the cavity is very much disintegrated by the inflammatory process the wound will do better if is first packed with strips of iodoform gauze. Exsection or amputation may be necessary, but this question must depend upon the conditions presented in each case.

Chronic synovitis may result from the acute form, or it may be chronic from the start and remain so. The joint is much swollen, without heat or pain, and fluctuates all over; the fluid collects chiefly in the mucous bursæ adjacent, especially at the knee, where the bursæ under the tendons of the extensors at both sides of the patella and in the popliteal space are greatly distended, while the capsule is less distinctly marked than in acute synovitis; the patient can often walk easily, but much exercise is fatiguing and followed by increased effusion.[2] The cure requires rest to the joint, and change in the synovial surfaces. Rest may generally be best secured by plastic dressing, both in the upper and lower extremity. To effect a change in the synovial membrane apply blisters or iodine; if it still remains filled with fluid, it may be tapped with a fine trocar, and the fluid withdrawn; or, if the fluid return, to tapping add an injection of iodine. The arrest of secretion in the latter case is due to the shrinkage of the serous membrane caused by the action of the iodine, with the new formation of endothelium.[1] Tap the joint carefully with a fine trocar, and after the escape of the fluid, without admitting air, inject by means of a well-made syringe officinal tincture of iodine and distilled water, equal parts, or, if it is desired to be more cautious, take one of the former to two of the latter; be careful that no air enter the joint; allow the liquid to remain from three to five minutes, according to the pain induced, then let it escape slowly, close the wound, and envelop the joint with wet bandages; the operation is not free from danger and may terminate in purulent synovitis.[1] Or, the joint may be irrigated with antiseptics. Use a medium sized trocar and canula, puncture by the inside of the patella near its lower end and withdraw the fluid, then distend the joint with bichloride solution, 1–10000, and let a stream flow through the joint for several minutes, close the puncture with suture, and apply iodoform dressings.

---

[1] J. Lister.

[2] T. Billroth.

II. CARIES.

Two forms of destructive ulceration occur in the articular extremities of bones, which are liable to seriously compromise joints.

Simple caries[2] attacks the articular ends of bones as a sequel of inflammation of other tissues of the joint; it begins when the cartilage which coats the articular surfaces is finally destroyed, and the bare bone is left projecting into the cavity of the joint; by mechanical violence minute portions of bone tissue are successively detached with the débris which surrounds them; the ulcer is invariably superficial, sharply circumscribed, and relatively smooth; it is commonly situated where the opposed surfaces are in contact with each other; though slow in its progress it causes extensive losses of substance followed by marked shortening and distortion of the limb. The first symptoms may be slight heat, pain, and swelling, followed in a few weeks by gnawing pains and starting of the limb at night from spasms of the muscles, great pain on rubbing the joint surfaces together, contraction of the limb; finally pus forms and abscesses appear with their attendant symptoms.[1] The indications of treatment are tonics, as syr. ferri iodid. and cod-liver oil, and complete relief of the carious bone from pressure and friction, by extension with apparatus adapted to the special joint involved. If the caries extends, exsection or amputation may be required.

Fungating caries, fungous or scrofulous inflammation of a joint may originate in the synovial membrane, or there may be a central or more rarely a peripheral caries in the spongy epiphysis of a hollow bone or in one of the spongy bones of the wrist or ankle which may perforate from within outward and excite synovitis; sometimes in the hip, knee, and ankle with the fungous proliferation of the synovial membrane, there is an independent proliferation under the cartilage and between it and the bone, which subsequently unites with that

[1] T. Billroth.

[2] E. Rindfleisch.

above, so that the cartilage lies partly movable between the two granular layers.[1] More commonly the disease commences as a non-suppurative inflammation of the adjoining epiphyses of two bones where they unite to form a joint; the hyperæmic medulla grows towards the joint, the bony trabeculæ melt away, the cortical portion becomes thin, the exuberant granulations protrude between the cartilage and bone; meantime the synovial membrane and its connective tissue, the ligaments, and, finally, all of the neighboring connective tissue inflames; a diffuse congestion occurs in the delicate, overlapping fringe of the synovial membrane, from which a membrane of young connective tissue overspreads the cartilage from its edges; the superficial layer of cartilage cells now takes part in the inflammation, cells multiply, the capsules open, the young connective tissue forces its way in; finally, the ascending growth meets that which is advancing downwards, the two coalesce, and the cartilage is perforated.[2] The disease may terminate in resolution, and the parts recover, or pus may form in the joint or in the tissues around it, creating abscesses with sinuses; or the connective tissue may enlarge and degenerate into a firm, white, fibroid mass of colossal dimensions, stretching the skin all around the joint and shining through it with a whitish lustre, causing the so-called white swelling, tumor albus.[2] The external appearances of the affected joint depend upon the extent of participation of the parts around the joint in the inflammation; there may be no suppuration but a simple proliferation of granulations which shall lead to destruction of ligaments and displacement of bones; or suppuration may occur in the granulations or synovial membrane, or in the connective tissue; whatever swelling there may be around the joint is due, not to enlargement of the articular ends of bones which never swell in caries, but to the thickening of the soft parts or to osteophytes.[1] The disease is frequent in childhood.

When fungating caries attack spongy bones, which are largely invested by articulations, as the carpals, tarsals, and vertebræ, the bone may be entirely dissolved by interstitial granulations growing all through it without any necessary accompaniment or the slightest trace of suppuration.[1] But in the great majority of cases there is a purulent periostitis, especially of the carpal and tarsal bones, and the disease readily extends to the entire bone and its articular surfaces as it progresses; the sheaths of tendons become implicated, the skin ulcerates, giving exit to the pus, and the joints swell and lose their shape. The atonic form of inflammation with slight vascularization which results in caseous degeneration of the new formation, the so-called scrofulous caries, is essentially a fungating caries. It occurs chiefly in the spongy bones, the vertebræ, the calcaneum, and epiphyses of hollow bones, and readily combines with partial necrosis.

The essential feature of treatment of a carious joint is perfect rest of the part, combined with open air, syr. ferri iodid. and cod-liver oil. Rest must be obtained either by position or apparatus. In the upper extremity both methods may be usefully resorted to, but in the lower extremity apparatus should be so employed as to prevent all injurious movements of the joint, and yet permit of that general exercise essential to the health of the patient. The hip, knee, and ankle-joints may be placed at rest, and efficiently protected by the gypsum bandage, but well-fitted apparatus gives more precision to the efforts to protect them and yet allows free out-of-door exercise. In the early stage this course may secure resolution; later it may be followed by fibrous anchylosis, to be relieved by flexion; finally, in the stage of suppuration, it may result in bony anchylosis. At various stages of progress the question of exsection and amputation will be raised and must be determined. The apparatus necessarily varies at each joint, but the principle is the same.

---

[1] T. Billroth.

[2] E. Rindfleisch.

The vertebræ are very liable to fungating caries, Pott's disease. It usually affects the cancellous tissue of the vertebral centre, and results in a cheesy metamorphosis, beginning in the interior of the mass of granulations and gradually extending in all directions; these deposits, chiefly situated in the anterior half of the bodies of the vertebræ, soften into a pus-like fluid, which escapes by stripping off the periosteum, and the longitudinal ligaments of the column in front of which it accumulates, and then gravitate downwards; the intervertebral disks either escape the inflammatory changes altogether, or become involved at a relatively late stage of the disease; the result of the disorganization is relaxation of the union between the vertebræ, which favors dangerous displacements, as of the atlas, and angular curvatures.[1] The disease begins very insidiously with obscure symptoms referable to the nerves of the affected region; if in the lumbar region, there are pains in the legs and hypogastrium; if in the dorsal region, the pains will be in the epigastrium, and are frequently treated as indications of stomach and bowel derangements; if in the upper cervical region, the pains are in the chest or back of the neck and head. As the destructive ulceration progresses there is increasing weakness of the spine, with languor, inability to stand long erect, avoidance of all jarring movements, and if the upper cervicals are diseased, a disposition to support and protect the head with the hands applied to the chin and occiput; displacement in the form of a sharp posterior angle next appears, revealing positively the nature of the affection; finally, pus gravitating from the affected vertebræ accumulates as a congestive abscess beneath Poupart's ligament or in the lumbar region.

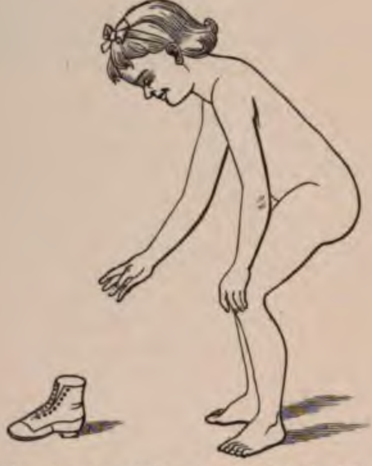
In the early stages the diagnosis is often obscure, but it is very important to make it out clearly before curvature takes place. Undress the patient so as to completely expose the spine, and note any irregularities of the spinous processes. In infants, sitting, there is a uniform bending of the whole spine, which makes the spines prominent, but no one is markedly projecting; this has been mistaken for caries. Direct the patient to pick some article from the floor, which act reveals a stiffness of the spine. The patient inclines to sit down, rather than stoop, to avoid bending the spine (Fig. 143). If the disease is cervical, a slight tap on the head causes pain; if it is dorsal or lumbar, the patient shrinks from rising on his toes and falling heavily on his heels. There is rarely any local pain or marked tenderness at the seat of the disease, except on percussion.

When the disease is more advanced there is a prominent backward curve, a pendulous abdomen, and a slightly stooping attitude (Fig. 144). The most prominent spine always indicates the body of the vertebra originally involved.

---

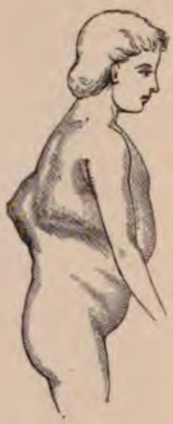
[1] E. Rindfleisch.

Fig. 143.



Early dorsal caries; child cannot bend the back in stooping; and supports weight by hand on knee.

Fig. 144.



Attitude of child in angular curvature in advanced stage.

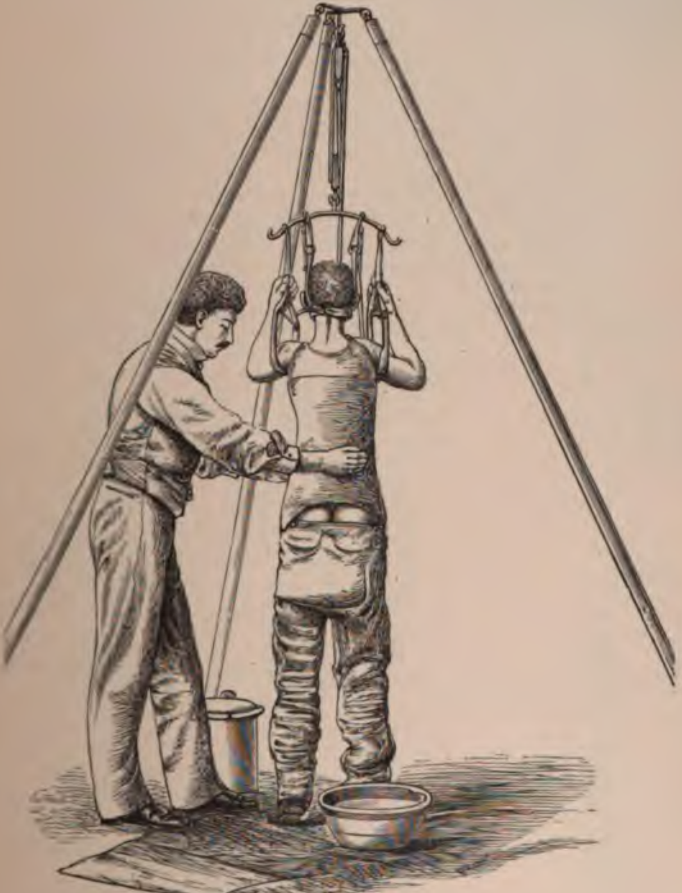
The indications of treatment are (1) improvement of the general health; (2) protection of the diseased vertebræ from injury; (3) management of spinal abscesses. (1) For the general health, tonics and good hygienic conditions are always required. (2) Protection of the diseased vertebræ from the injury which the superincumbent weight of the body induces, requires judiciously applied apparatus. Of the various dressings employed the gypsum bandage is the most convenient and useful in general practice. It is designed to furnish an immovable apparatus which by uniform pressure around the entire trunk shall sustain the broken column in a fixed position. It is desirable to have the spine extended, but without undue tension of the diseased structures, and for this purpose the patient may be held, if a child, by the hands in the axillæ, or by adhesive strips applied to the front and back of the body and looped over the shoulder,[1] or by any means which secure extension of the spine, as lying face downward, with shoulders and hips resting on two chairs, the body being free. But more perfect results are obtained by using a suspending apparatus (Fig. 145) consisting of pulleys and cross-bar to elevate the body with an adjusted chin sling, and axillæ straps. The gypsum dressing is thus prepared and applied:—[2]

Select some loosely woven material, as mosquito netting, or crinoline; tear it into strips three yards long and two and a half to three inches wide, according to the size of the patient; draw them through very fine and freshly ground plaster-of-Paris which sets quickly, and rub the plaster well into the meshes; roll them up loosely; apply to the patient a tightly fitting shirt of elastic, soft woven, or knitted material, without arms, extending to the middle of the pelvis, and fastened over the shoulder by tabs; apply the chin-piece of the apparatus, place the arms in the axillary bands and raise the patient by the pulley gently and slowly, and never beyond the point at which he begins to feel uncomfortable, and which usually admits of the feet resting on the toes (Fig. 145); over the abdomen between the shirt and the skin place a pad composed of cotton folded in a handkerchief so as to form a wedge-shaped mass, the thin edge being directed downwards, its purpose being to leave a space after its removal when the bandage is firm for the expansion of the abdomen during meals; bandages, placed on the end in a basin of water until the bubbles cease to rise, are squeezed until the surplus water escapes and then passed round and round the trunk, beginning at the smallest part, and extending downwards a little beyond

---

[1] J. A. Reed. [2] A. L. Sayre.

Fig. 145.

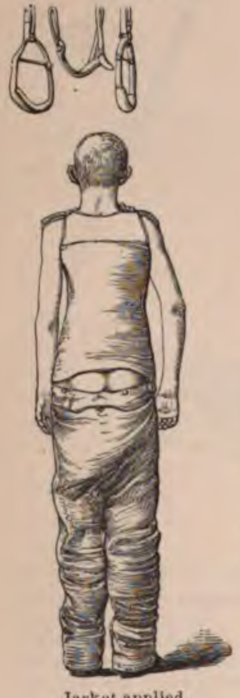


Application of Sayre's plaster jacket.

the crest of the ilium, then upwards in a spiral direction until the entire body is encased from the pelvis to the axillæ; pads of cotton are to be applied over any very prominent spinous process or other bony projections which may be inflamed from previous pressure, or liable to be irritated; if the patient is an adult female place pads over the breasts to be removed when the plaster is firm; the bandage should be placed smoothly but not tightly round the body, being simply unrolled with one hand and smoothed so as to be adapted to all the irregularities by the other; after one or two thicknesses have been applied, narrow strips of roughened tin or zinc should be placed on either side and parallel with the spinous processes, and others added at intervals of two or three inches until they surround the body; over these apply another bandage; the plaster sets rapidly, and the patient may soon be taken from the apparatus and laid upon a hair mattress; the pad must be removed from the abdomen and the bandage pressed firmly about the anterior superior spines and from the breasts when used, and compression made against the sternum to fix the part firmly; if the bandage irritates the spine an opening may be made at that point (Fig. 147). The patient must remain quiet in the recumbent position until the dressing is firm, when he may rise (Fig. 146). The abdominal pad may be dispensed with, and firm support given by the bandage to the lower part of the abdomen, but an opening should be cut in the dressing, corresponding with the stomach, after the bandage is firm to relieve the constriction (Fig. 148). Additional fenestræ are often required as at the curvature, or where sinuses are discharging.

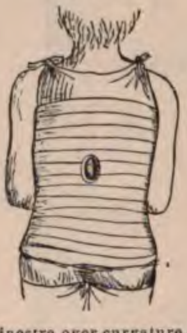
The compensative curves of the spine may be more completely straightened by inducing profound anæsthesia before suspension, and experience proves that there is no danger during anæsthesia, either in the position of the patient or in the compression of the thorax by the gypsum, even if the patient remains suspended, as is usual, until the dressing becomes firm.[1]

Fig. 146.



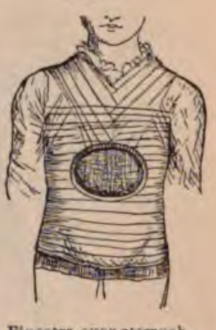
Jacket applied.

Fig. 147.



Finestra over curvature.

Fig. 148.



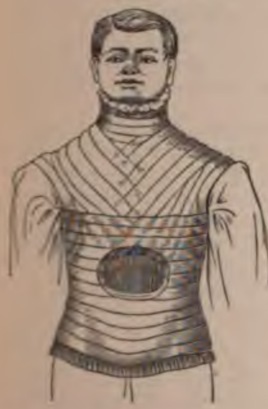
Finestra over stomach.

If the diseased vertebræ are in the lumbar or lower dorsal regions the bandage need not be applied higher than the axillæ, but if the caries exist in the upper dorsal region there must be additional support of the upper part of the thorax, and this is obtained by continuing the bandage over the shoulders, and thus encasing the entire trunk in the common dressing (Fig. 148). When this form is used the arms must not be in the sling but should hang by the side. By this means the spine can be permanently maintained erect. When the caries attacks the cervicals, means must be used to so support the head that the contiguous vertebræ may not be compressed. This may be accomplished by supporting the chin, or by lifting the head entire. The chin may be sustained by extending the plaster-of-Paris jacket upwards as a cravat, well lined with cotton batting, or other soft material (Fig. 149). Or, the head may be raised entirely from the column by an appliance (Fig. 150) so incorporated in the plaster bandage that it has a firm basis of support, and by a sling which accurately fits the chin and occiput and lifts the head directly upwards (Fig. 151).

---

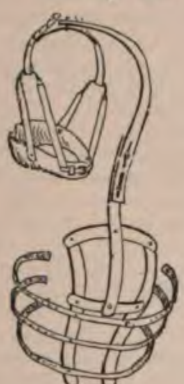
[1] Von Langenbeck.

Fig. 149.



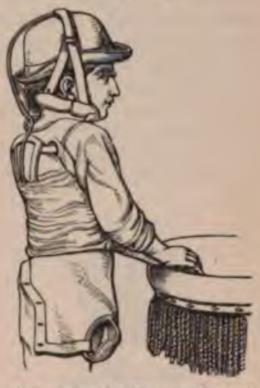
Plaster dressing for cervical caries.

Fig. 150.



Jury mast.[1]

Fig. 151.



Apparatus for disease of cervical or upper dorsal spine plaster jacket with "jury mast."[1]

To apply the apparatus the patient is suspended in the usual way, from the axillæ, chin, and occiput, and the plaster bandage applied, as usual, over a tight-fitting knit or woven shirt. After the bandage has been accurately applied, the patient is removed from the suspending apparatus and carefully laid upon a firm bed until the plaster has hardened or "set." The patient can then stand up, and the apparatus for suspending the head is applied in its proper position, over the back of the plaster jacket, and the lower portion of it bent and moulded until it accurately fits all its various curves. The loose tin strips, being very flexible, can then be smoothly moulded around the jacket which has already been applied to the trunk, and another plaster bandage having been wetted in water, is to be carefully and tightly applied over the apparatus and jacket first applied, in sufficient number of layers to make it perfectly secure. The tin being rough and perforated, a sufficient amount of plaster will be incorporated into its holes and meshes to prevent any possibility of displacement. We have now a secure point of support from the pelvis and trunk, and the head can be sustained by properly adjusting the movable rod and securing it by screws (Fig. 151).

The gypsum dressing may be worn without change from two weeks to two months, according to the effect which it produces; when renewed, the patient should be thoroughly washed, but without assuming the upright position, except when the head is well supported. The final cure is rarely completed in the most successful cases in one year.

---

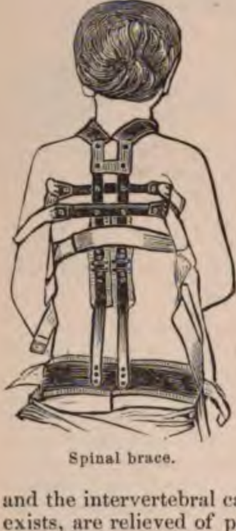
[1] L. A. Sayre.

There are several kinds of useful apparatus for spinal caries more or less complicated in their mechanism, and requiring great experience and care in their successful management, but the plaster-of-Paris jacket is to be preferred on account of its efficiency, durability, and economy.

A very neat and efficient spring corset[1] may be so constructed and applied as to protect the diseased vertebræ from injury, and allow great freedom of motion of the trunk; the springs are brass, of a serpentine form, especially tempered, elastic, and, by a little manipulation, readily adapted to any surface, however irregular or uneven, to which they are applied; in their spring-like action exists an elevating power, an auxiliary to the local and general support rendered, the tendency of which is to take off the superincumbent weight of the body from the diseased vertebræ.

A spinal brace[2] may be so applied as to take the weight of the trunk above the point of disease from the bodies of the vertebræ and throw it on the articular processes. There are two pieces or levers passing up the back, not over the spine, but each side of it, so that it is firmly held from lateral deviations; to the upper end of these two curved pieces of steel are fastened diagonally on both sides of the neck; they pass directly forward and around the shoulder, and thus prevent a great loss of force by diagonal action. The arrangement entirely obviates the painful and injurious ligaturing of the arms, which would occur if the straps passed forward from one point. At the part opposite the point of disease, the point where the fulcrum pads are placed is made of chamois skin or Canton flannel, filled with cork filings, which have no felting qualities, or, if desirable, can also be made of hard rubber; the shoulder-straps and the band around the hips are likewise provided with similar pads to protect the skin from pressure and abrasion; the instrument, like the spine itself, acts like a double lever with a common fulcrum at the curvature; this action is directly backward at the hips and shoulders and directly forward at the middle of the back, or wherever the diseased part is located; thus the posterior portion, the only healthy portion of the diseased vertebræ, is made to support a part of the weight of the body, and the intervertebral cartilage and bodies of the vertebræ, where the disease exists, are relieved of pressure. The abdomen is still further sustained in the upward direction by an apron in front which is fastened on each corner. If the disease is in the upper dorsal or cervical region, an apparatus is constructed for such cases with an attachment for sustaining the head; the effect and form of this attachment is that of a lever, acting backwards to raise the head and neck.

Fig. 152.



Spinal brace.

Spinal abscesses may find their way to the surface by very circuitous routes, and appear at unusual points quite unexpectedly. In general, however, they appear as lumbar, iliac, or psoas abscesses. They should be opened antiseptically as soon as discovered. By delay in operating, especially on iliac abscesses, they increase in size, involve new areas, impair the general health, and constantly menace the life of the patient. By opening them no danger of suppuration is incurred as formerly, but, on the contrary, the general health is improved and the carious process may be arrested. Operate as follows: The surfaces having been well cleaned and shaved and the operator's hands being disinfected, under irrigation with bichloride solution, 1–1000, make a free incision through the overlying tissues into the abscess. If the abscess is iliac, the dissection must be more cautiously made. The cavity being exposed cleanse it of all dead tissues and scrape off the granulations; now explore the cavity, and, if the sinus leading to dead bone can be found, gently pass a soft catheter along the track and carry it, if possible, to the abscess cavity. Along that track it may be possible, especially in the lumbar and lower dorsal regions, to dissect a passage so as to give a full exposure of the carious vertebra, and enable the operator to remove the dead bone and cleanse the cavity of all débris. If the carious cavity cannot be exposed, it may still be irrigated through the catheter, and the disease may be arrested. The abscess should be thoroughly washed out with a weak bichloride solution, 1–5000, a drain-tube inserted, the wound closed, and iodoform dressings applied.

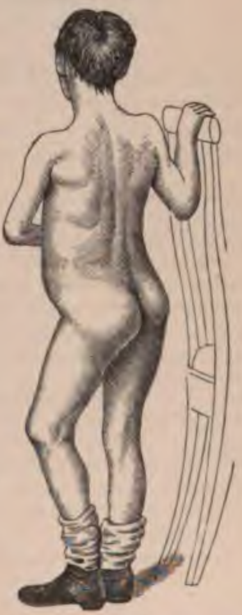
---

[1] J. A. Wood.

[2] C. F. Taylor.

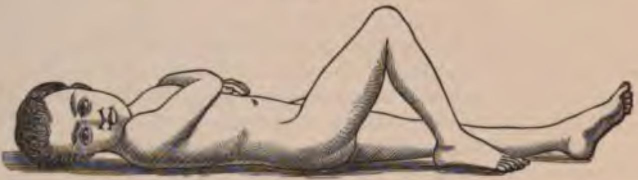
The hip-joint is liable to caries which may commence in the head of the femur, or in the acetabulum, or may result from primary inflammation of the round ligament. The symptoms are very nearly uniform whichever part is first attacked. The early symptoms are flexion of the thigh, wasting of the limb, pain in the region of the knee; the patient may still exercise freely for months, but often cries out at night from startings of the limb. As the disease progresses the thigh becomes everted, more flexed and fixed, and the patient uses the limb less freely or not at all; then the capsule ruptures, inversion and flexion follow, the head of the bone is displaced upwards, and in this position anchylosis occurs, or death from exhaustion. The diagnosis should be correctly made at the earliest period. Undress the patient and examine first as to the symmetry of the hips. If the joint is affected the knee of that side will be slightly bent, the buttock widened and flattened (Fig. 153), and the gluteal fold oblique instead of transverse. Now, place the patient on his back on a smooth firm surface, and notice as to the following signs: If there is disease of the right hip, and the spinal column lies straight on the surface, the right thigh will be elevated to an angle corresponding with amount of flexion, while the other limb will lie in a straight position (Fig. 154); but if this limb is placed beside the other and the knees pressed down

Fig. 153.



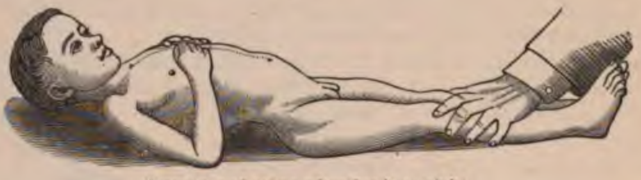
Appearance of hip when disease is advancing firmly, the back will arch (Fig. 155). The treatment is protection of the joint from pressure and concussion. The long hip splint should be applied as soon as the disease is recognized, and be worn day and night while the symptoms continue. There is no surgical apparatus that so completely fulfils every indication in any case as a properly constructed and adjusted hip splint in hip-joint disease. There are several forms of hip splint,[1] all constructed on the same principle, but one of the most simple, cheap, and effective is made and applied as follows:—

Fig. 154.



Position of leg when spine is straight.

Fig. 155.



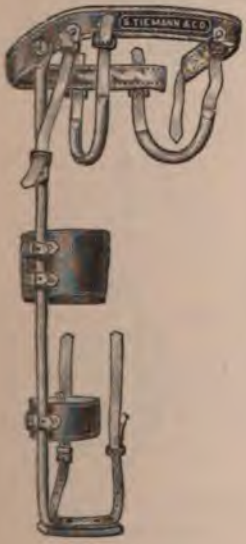
Curvature of spine when leg is straight.

The splint (Fig. 156) extends from the sole to the crest of the ilium, where it is connected to a pelvic band by a joint allowing flexion and extension, abduction, and adduction, but properly regulated. Extension is made by means of adhesive plaster applied to the leg and attached by buckles to the two ends of a leather strap fastened to the foot-piece; counter-extension is made by means of two perineal pads fastened to the pelvic band with straps and buckles; at the knee-joint is a movable cross-piece for attaching a leather cap to steady and support the knee; at the bottom of the instrument is a foot-piece with a leather sole attached, to prevent jar in walking; a leather strap, passing under the foot, through apertures in the foot-piece, turns up an end on each side of the ankle, and fastens to buckles in adhesive strips, which prepare as follows: Cut two pieces of strong plaster, to reach from the middle of the thigh nearly to the ankle and two inches wide; attach a strong saddler's buckle to the lower end of each; apply the plasters against the lateral aspects of the leg, beginning about two inches above the internal and external malleoli with the ends having the buckles attached; a few turns of roller bandage are then made around the ankle, just under the lower ends of the straps, to protect the flesh under the buckles, and then continued over the strips on the whole limb; the patient should be laid on his back, and great care ought to be taken that the pelvis is not inclined forward by contractions of the flexor muscles; should this be the case, elevate the leg until the lumbar vertebræ come near the couch and the spinal column assumes its normal shape; the instrument is then applied; the pelvic band ought to be loose enough to allow the pelvis to move freely in it; the anterior superior spine of the ilium ought to be above the pelvic band (Fig. 157); in applying the ankle straps leave a little space between the foot and the foot-piece so that in standing or walking the weight of the patient does not rest on the leg, but on the instrument; the perineal straps must be so adjusted that the patient sits firmly and comfortably upon them; when the apparatus is adjusted tighten the perineal straps until the patient gives evidence that the strain is sufficient. The attendant should be instructed to keep all the straps as tense as the patient will bear without complaint.

---

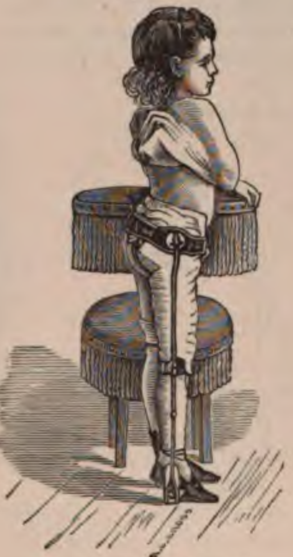
[1] A. C. Davis; C. F. Taylor; L. A. Sayre.

Fig. 156.



Hip splint.

Fig. 157.



Hip splint applied.[1]

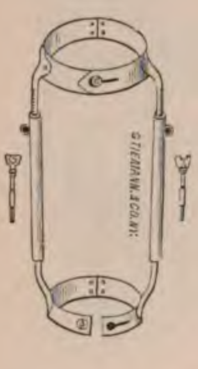
In the subsequent progress of the case all abscesses should be opened as soon as detected, the pus evacuated, and if they do not communicate with the joint, they should be cleansed of all débris and granulations with the spoon, irrigated thoroughly with bichloride solutions, drains inserted, and iodoform dressings applied. Usually such abscesses heal promptly. If the abscess extends to the joint the exploration should continue until the source of suppuration is discovered. Wherever carious bone is found it should be thoroughly removed with the curette or saw, according to the location or condition of the diseased bone. No more bone should be removed than is necessary for a complete removal of the diseased portion.

The knee-joint is very liable to caries. The disease causes at first but slight symptoms for months, as dragging of the leg or limping, pain after exercise, or on pressure; then there is swelling, the joint is evenly rounded, quite sensitive to pressure; gradually the joint becomes more and more angular and painful, so as to prevent walking; certain points become more painful and red, with fever; fluctuation is detected, and soon after a thin pus, mixed with fibrinous cheesy flocculi, escapes; the symptoms at first improve, but soon another abscess forms with fever; these symptoms are repeated, attended by gradual emaciation, wasting and flexion of the limb; the disease may terminate fatally by extension, or recovery may follow with anchylosis of the affected joint. The knee-joint should be firmly fixed, and still allow of exercise. The gypsum bandage—applied from the middle of the leg to the middle of the thigh—may be used. The most efficient brace[1] is made of steel bands (Fig. 158), connected by extension rods, with rack and pinion. Or the gypsum bandage above and below may be connected by two brackets (Fig. 160).[2]

---

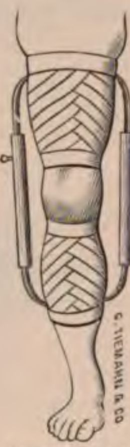
[1] L. A. Sayre.

Fig. 158.



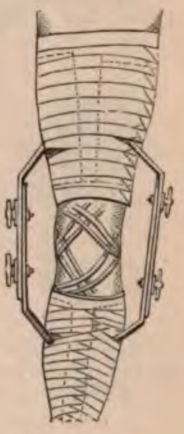
Knee extending splint.[1]

Fig. 159.



Splint applied.

Fig. 160.



Gypsum splint.[2]

For the steel brace: select adhesive plaster, spread on strong cloth and cut it in strips one inch wide, and long enough to reach from just below the knee to near the ankle, and also from the knee for several inches above the joint, upon the thigh. Secure these plasters to within an inch of their extremities by a snugly-adjusted roller (Fig. 159); place the instrument on the limb, the collars fastened sufficiently tight to be comfortable, and the loose ends of the adhesive plaster turned over them and secured by a roller; extend the connecting rods by turning the key.

The gypsum is applied above and below, and when hard the brackets (Fig. 160) are adjusted and fastened by additional layers.

The ankle-joint is affected by caries as a chronic inflammation, causing enlargement of the parts about the articular ends of the tibia, or malleoli, with the final formation of abscesses and exposure of the joint. This joint may be very well protected by the gypsum bandage, applied from the toes to the middle of the leg. Or there may be an ankle-brace of steel (Fig 161),[1] or of gypsum (Fig. 162).[2]

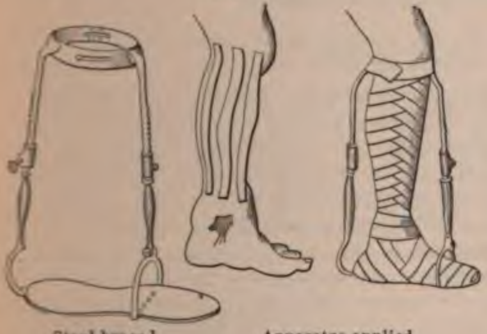
---

[1] L. A. Sayre.

[2] C. F. Stillman.

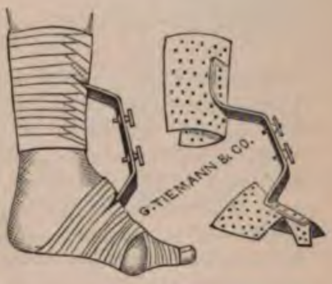
The steel brace is applied[1] (Fig. 161) as follows: Cut adhesive plaster in strips about one inch in width and long enough to reach from the ankle to near the tubercle of the tibia, and placed all around the limb; secure the plaster in its position, to within an inch of its upper extremity, by a well-adjusted roller, as seen in Fig. 161; fix the instrument and secure the foot firmly by a number of strips of adhesive plaster.

Fig. 161.



Steel brace.[1] Apparatus applied.

Fig. 162.



Gypsum apparatus.[2]

In applying the gypsum brace, the foot, held at a right angle, is wound with plaster from the base of the nail of the great toe as far as the disease extends, and from above the ankle almost to the knee (Fig. 162). The bracket is placed in position and bound down by repeated turns of the plastered bandage, taking care that the foot is still at right angles; the whole is neatly covered with fresh bandage.

The carpal and tarsal joints, affected by caries, may undergo very marked changes. The swelling becomes puffy and shining; the tenderness is extreme, especially on pressing the surfaces together. Abscesses next form with sinuses, and the bones are gradually displaced. The general treatment is tonics with cod-liver oil, good food, out-of-door exercise; appliances which maintain perfect rest must be at once employed, and such extension as relieves pressure upon the diseased bones. The carpus may be maintained upon a well-padded palmar splint, with extension by adhesive strips applied to the fingers and attached to the projecting extremity of the splint; the tarsus is best immobilized by the gypsum dressing.

If the caries advances proceed as follows: Cleanse and shave the limb; apply the elastic bandage from the extremity above the wrist or ankle, first covering the diseased part with cotton. The hands of the operator being clean, and the irrigator with bi-chloride, 1–1000, at work, make such incisions as will fully expose the carious bone or bones; the incisions should be in the direction of the tendons and vessels, or they may be semi-circular, as around the malleoli; the joint being opened all of the granulation tissue and carious bone should be carefully removed with the scissors or spoon; carious cavities should be scooped out; all recesses where there is diseased tissue should be cleaned and well irrigated. Insert drainage tubes into deep cavities and close the wound, or pack the wound with strips of iodoform gauze and cover it with iodoform pad and sublimate gauze bandage; over this place a layer of borated cotton, and finally apply three layers of gypsum bandage; cut openings opposite the drains and suspend the limb. Change the dressings as seldom as possible after the first dressing, which should be in three to six days. Such wounds, thoroughly treated antiseptically, rarely suppurate, but heal rapidly. The former method of introducing setons should be abandoned.

---

[1] L. A. Sayre.

[2] C. F. Stillman.

III. LOOSE BODIES.

These bodies in the knee-joint are outgrowths of cartilages in chronic rheumatic arthritis, or in the dendritic growth of synovial fringes accidentally detached, or portions of the proper articular cartilage with or without some subjacent bone which has been exfoliated into the joint.[1] The symptoms are slight pain in the knee with weakness, and often moderate dropsy, and at length sudden pain and inability to walk while the knee stands between flexion and extension, due to the loose body being caught between the bones forming the joint, or the semilunar cartilages, or in one of the synovial sacs; it may at times be detected and fixed by external manipulation.[2] When very troublesome, it must be removed by the antiseptic method. Cleanse the surface and use bichloride solution irrigation during the operation; fix the body and make a free incision upon it. When the cartilage is removed irrigate the wound, introduce a small drain, close the incision with prepared catgut, apply iodoform dressings, and immobilize the joint with gypsum bandages.

Cases of suppuration in the joint after an antiseptic operation for loose cartilages are occasionally reported, but it is seldom difficult to trace the failure in these cases to some minor and yet vital point in securing cleanliness, or in the employment of the agents of antisepsis, or in the methods pursued.

If the operation is performed without the use of antiseptics, the utmost care must be taken to protect the joint from the entrance of air; force the body tightly under the skin at one side of the joint, press the skin strongly upward, and put it still more on the stretch, then cut through the skin and capsule down upon the body, and let the latter spring out, or lift it out with an elevator; instantly close the wound with the finger, extend the leg, let the skin return to its normal position so that the cut in it lies lower than in the capsule, and the two wounds do not communicate directly; close the skin wound with sutures and plasters; extend the limb on a splint, or apply the gypsum dressing before the operation, and make a large opening over the joint.[2] The subcutaneous incision may be made, and the body forced into the connective tissue, where it is allowed to remain or is subsequently removed.

---

[1] Sir J. Paget.

[2] T. Billroth.

CHAPTER XX.

THE RESECTION AND EXCISION OF BONES.

THE terms resection and excision are frequently used as synonymous, but though the definitions of the two words are not unlike, there is a different and distinct meaning attached to each when properly employed. Resection strictly implies the removal of the shaft of a long bone, while excision means the removal of the joint ends of bones, or the extirpation of a short, flat, or irregular bone. As the operations are closely allied in many respects, it will be more convenient to group them under one division, preserving these distinctive meanings.

The great improvements in the use of antiseptics has enlarged this field of useful operations. It is possible now to avoid many of the former dangers of excision, such as excessive suppuration and secure rapid union of bone. The former statistics of the results of these operations before antiseptics were scientifically employed are now of only historical value, and are omitted.

The indications for these operations are in general as follows:—

(*a*) Resection of bone in part or whole is required after injuries which have destroyed its vitality, or after diseases which have resulted in caries or necrosis, or in the removal of tumors; but the operation is justifiable only when it is evident that resection is preferable to every other remedial measure.[1] When undertaken it must be so planned and executed as to become the first step in a process of repair by which a part is restored to more or less complete usefulness that would otherwise have been sacrificed.[2] The operation must be determined by the condition of the patient and of the diseased part. In general the operation is indicated only when the general health admits; for if the patient is suffering from a progressively wasting disease, as tuberculosis or marasmus, which will necessarily prove fatal, resection would be unwise, as repair would not follow.[3] In injuries, as gunshot, only such fragments of bone should be removed as are nearly or quite detached from the periosteum. In caries of hollow bone the ulcer may be thoroughly cleaned out with the gouge and the cavity be allowed to close by granulation,[4] but if the bone is small, extirpation may be necessary to arrest the process at once.[3] If a hollow bone is affected throughout, as with periostitis, external and internal caries, partial internal and external necrosis, extirpation of the entire bone may be required, as the only alternative of amputation.[3] Tumors of bone,[5] if not malignant, must be removed from their locality, but if malignant, extirpation of the bone or wide resection is necessary.

(*b*) Excision of a joint is necessary for shot injuries, the comminution of the joint ends of the bones, or the impaction of a ball in the end of the bone in such manner that it cannot be removed without destruction of the bone; in compound dislocation with extensive in-

[1] F. C. Skey.
[2] A. Wagner.
[3] T. Billroth.
[4] C. Sédillot.
[5] Sir J. Paget.

jury of the soft parts, or complicated with fracture; in caries which has destroyed the articular surface, and continues to progress in spite of well-directed efforts to control it.

Compound dislocations and fractures involving joints once so fatal from inflammation, do not now always necessitate excision, for when antiseptic methods are rigidly enforced from the first, suppuration does not occur.

The time of operating after an injury, as a gunshot, should, if possible, be within twenty-four hours of the accident, or primary; if it is delayed beyond this period it should not be performed until the intermediary stage of inflammation is passed.[1] If the bone is necrosed the invariable rule should be not to attempt removal before complete detachment, because the dead bone can rarely be sawed out without removing healthy and newly-formed bone; and the new bone is not firm enough before the sequestrum is detached.[2]

Fig. 163.

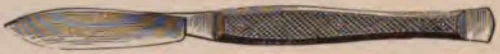
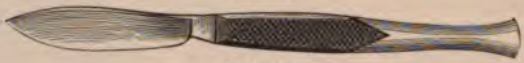
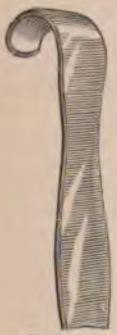


Fig. 164.



Scalpels.

Fig. 165.[3]



Retractor.

Fig 166.[4]

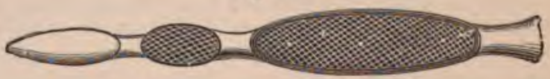
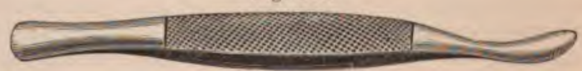


Fig. 167.[5]



Periosteotomes.

The instruments required in resection and excision may be few or many, both in number and variety, according to the nature of the case. (1) The knife (Figs. 163 and 164) should be broad and firmly set in a rough handle, which may or may not terminate in a periosteotome. (2) The retractor may consist of broad metal plates properly curved (Fig. 165), or take the form of hooks; the latter are less liable to slip out of the wound, but do not so effectually open it. (3) The periosteotome takes many forms (Figs. 166, 167); it is always a blunt instrument and in its use care must be taken not to contuse the periosteum when it is desirable to preserve its function. (4) The bone-cutting instruments are numerous and important. The straight bone forceps[6] (Fig. 168) is a most useful instrument in the section of the small bones, wherever it can be brought to bear. But frequently

[1] G. A. Otis.
[2] H. J. Bigelow.
[3] W. Parker.
[4] H. B. Sands.
[5] L. A. Sayre.
[6] R. Liston.

it is quite difficult to reach the part, which may be more readily divided with the forceps than the saw, unless the blades are curved at a considerable angle; in such cases a forceps curved (Figs. 169 or 170) will be found serviceable. The bone gnawing forceps (Figs. 171, 172), or rongeur, is indispensable in many resections, as it enables the operator to remove projecting parts not accessible to other instruments. The saw in one of its various forms is necessary. The chain saw (Fig. 173) consists of a number of pieces, with movable articulations, terminated at each extremity by handles with which it is worked.

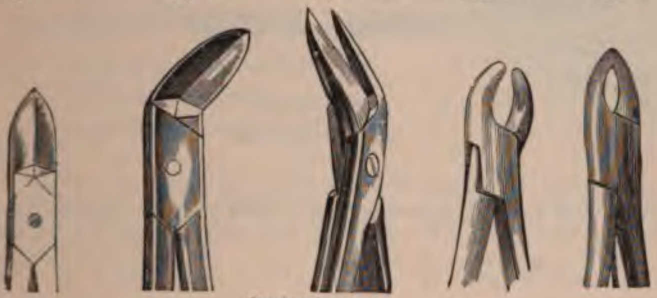
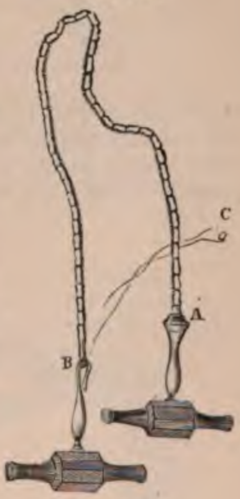


Fig. 168. Fig. 169. Fig. 170. Fig. 171. Fig. 172.

Cutting forceps.

To use this saw one handle is removed from hook, B, and a needle, C, armed with a strong thread, is attached to the end; the needle is passed under the bone, and the saw drawn into its position, with the cutting edge upwards, and the handle is then re-attached; the operator, grasping the handles, draws the saw alternately from side to side, until the bone is divided; there is great danger of breaking this saw if it is worked carelessly; it should be drawn from side to side steadily, at an angle of 45° to the long axis of the bone. The sections may consist of metallic beads strung on a wire with handles; such a saw will act efficiently in whatever direction it is held.[1]

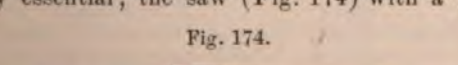
Fig. 173.



Chain saw.

Other saws, of peculiar shape, are often useful in the removal of certain bones, though not absolutely essential; the saw (Fig. 174) with a movable back may be used to advantage in most resections of bones of the extremities; in the removal of the superior maxilla, the right and left

Fig. 174.



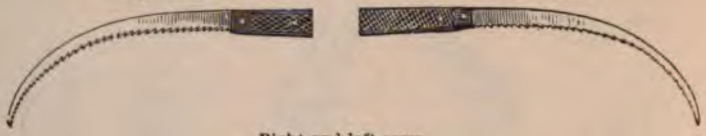
Saw with movable back.

---

[1] Tiemann & Co.

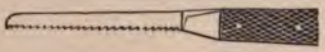
bone saws (Figs. 175, 176) enable the operator to separate its superior attachments with great facility; a small straight saw (Fig. 177) is often required and when it is necessary to use a part of the edge, an India-rubber tube may be drawn over the part unused to prevent its injuring the soft parts; occasionally a saw having a circular as well as a straight edge (Fig. 178) is required in removing sharp points, or thin bones; finally, a saw is essential, which may be taken from its position (Fig. 179) where it is firmly held by a spring, connected with the handle, and passed under the bone, if required, and the ends, being re-attached in the frame, the bone is as readily divided from beneath as from above; the saw may be turned laterally also, or be made to cut in a curve; the tension of the saw is regulated by a spring inclosed in the handle. Bone drills for the introduction of the wire suture must be provided, and an osteotrite will often be necessary (Fig. 180). The gouges, the chisel (Fig. 181), and the mallet (Fig. 182), are often required; to thoroughly clean out all forms of carious cavities, two or more gouges are necessary with different cutting edges; the mallet

Fig. 175. Fig. 176.



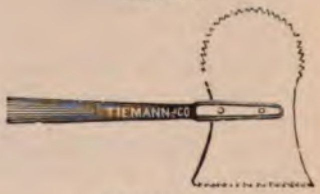
Right and left saws.

Fig. 177.



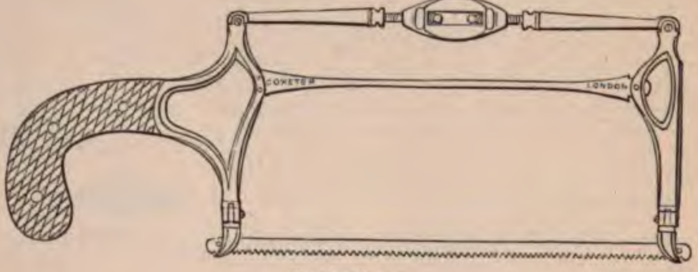
Straight-back saw.

Fig. 178.



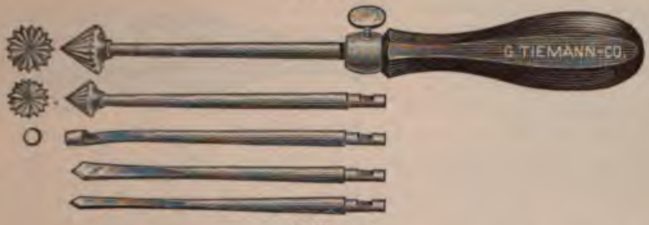
Hey's saw.

Fig. 179.



Butcher's saw.

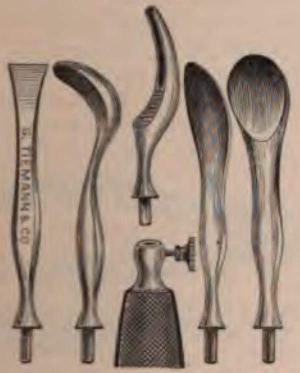
Fig. 180.



Drills.

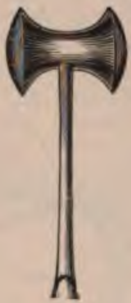
may be of wood or metal with a firm handle. (5) The seizing forceps may be the common dressing forceps (Fig. 183) for small fragments,

Fig. 181.[1]



Adjustable handle.

Fig. 182.



and larger forceps for large fragments (Fig. 184); they should also have straight and curved beaks (Figs. 185, 186) to seize fragments

Fig. 183.

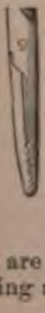


Fig. 184.[2]

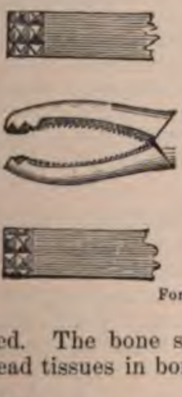


Fig. 185.

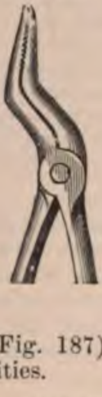
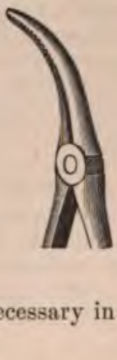


Fig. 186.



Forceps.

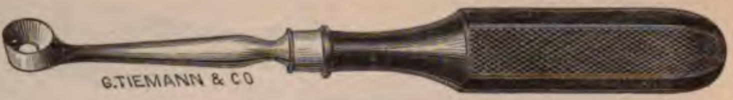
that are concealed. The bone scoop (Fig. 187) is necessary in removing all the dead tissues in bone cavities.

---

[1] J. T. Darby.

[2] Sir W. Fergusson.

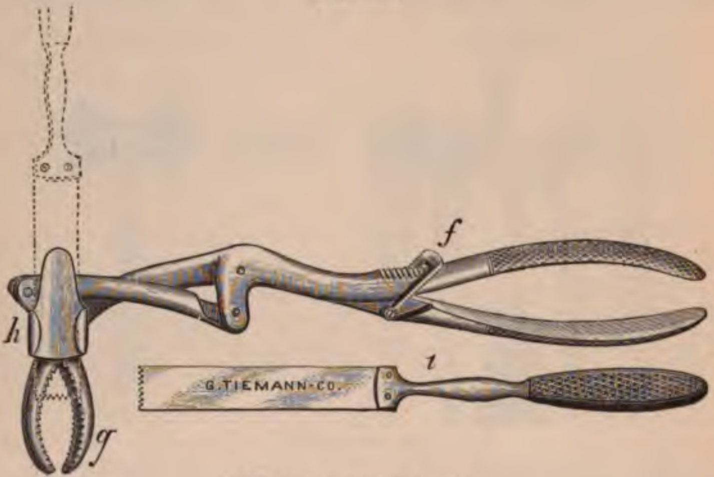
Fig. 187.



Bone scoop.

An instrument capable of seizing the bone and holding it in position, while a saw adjusted in it can be so operated as to divide the bone, is often desirable. Such an instrument has been devised,[1] and in modified form (Fig. 188)[2] has proved very useful.

Fig. 188.



Combined forceps and saws.

It consists of handles, having a fixation clamp, *f*; by opening or closing the handles the jaws, *g*, are separated or closed; the saw, *l*, is in shape like a chisel and works in a shield, *h*. The bone to be exsected having been exposed, with its periosteum peeled off in common with all the circumjacent tissues, the operator, holding the handle of the instrument in his left hand (the saw being entirely removed), opens the jaws, *g*, wide enough to insinuate them about the bone; as soon as this is accomplished, with the right hand slide the saw into the shield, *h*, down until the teeth engage against the bone; a slight oscillation of the handle of the saw with requisite pressure carries it through the bone with remarkable rapidity, and without wounding or bruising the contiguous soft tissues.

The preparations for the operation are as follows: Cleanse the hands and nails with soap, water, and nail-brush, and wash them in bichloride solution; put the instruments in the tray and cover them with carbolic acid solution 1 in 20; prepare the solution of bichloride, 1 in 2000, in the irrigator, the water being hot; while the patient is taking the anæsthetic wash the parts to be operated upon with soap and water, and shave the surface over a wide area; bind towels, wrung out of the bichloride solution, around the limb, one above and one below the point, and spread others over all the region of the wound, so as to protect the hands and instruments from contact with soiled surfaces or materials.

---

[1] Gowan.

[2] J. A. Wyeth.

The operation is as follows: (*a*) In resection, the part being well prepared, the elastic bandage should be applied unless there is infiltration of the cellular tissue with fluids, in which case it should be omitted.[1] The method of operating must be adapted to each particular case. In shot fractures the extirpation of fragments must be through openings extending from the wound; in necrosis the sinuses are guides for incisions; in the removal of the bone for morbid growths the incisions must be largely in the direction of the tumor. The incision in general should be made as nearly as possible over the bone to be removed, and distant from important bloodvessels and nerves; the soft parts should not be destroyed, except so far as they have undergone degeneration, or interfere with the proper closure of the wound; injuries to bloodvessels and nerves lying in the track of the incision should be scrupulously avoided by drawing them aside; muscles and tendons should, if possible, not be divided, nor their attachments incised, but should be separated to the least practicable extent with a blunt instrument. The bone being exposed to the desired extent, the next care of the operator should be to preserve in the wound, and, as far as possible, in its original position, the periosteum of the bone to be removed, in order to the reproduction of sufficient new bone to preserve the function of the part.[2] The periosteum is best preserved by first incising it to the extent of the bone to be removed, and then separating it with the periosteal knife. The periosteum being separated, the bone must be divided by cutting forceps or the saw, and each portion separately removed; if the saw is used, the soft parts should be carefully protected by compresses or a spatula introduced underneath it. In some cases the interior of carious cancellated bones may be scooped out, and the external shell be left as the basis of new bone.[3] The scoop may be a curved chisel, the periosteal knife, or other instrument which may be applied to the interior of the carious cavity. During the entire operation the irrigation must be continued, and until the wound is finally closed.

(*b*) In excision the operator should aim (1) to remove all diseased structures without needlessly sacrificing parts; in children, especially, the epiphyses of bones must be preserved with the most scrupulous care, to insure their future growth; in adults the amount of bone removed will always have regard to the future usefulness of the joint. (2) If the functions of the joint are to be preserved, as of the upper extremities, the fibrous structures which strengthen must be saved in their proper relations; the periosteum must be preserved with the attachments to the capsule; the muscular attachments must be separated uninjured, or with the bony fragments of their insertions to insure their future usefulness; the bones must be so shaped and placed in position as to maintain their special movements, preserving even a useful hinge-joint at the elbow.[4] (3) If the joint is to be anchylosed, as the knee, the surfaces of the excised bones must be accurately applied and maintained to secure firm union. The bones have been maintained in apposition by catgut, prepared silk, and by nails and metallic pins driven through the fragments, but no means has proven more serviceable than the wire. The silver wire is the best material for that purpose. It should be so inserted as not to require removal; viz., after being twisted cut it off and turn the ends downwards between the ends of the bones.

---

[1] F. Esmarch. [2] L. Ollier. [3] C. Sédillot. [4] H. J. Bigelow.

The treatment of resection and excision wounds should secure rest and freedom from irritation. Rest is obtained by apparatus which is adapted to each case; in general the immovable apparatus of plaster-of-Paris is most available and useful. Though these wounds generally heal by granulation, yet, by careful attention to the use of antiseptics suppuration may be almost entirely prevented. They are peculiarly liable to be poisoned by septic ferments from the putrefactive matters already existing in the wound. The dressings should, therefore, be scrupulously antiseptic throughout the stage preceding granulation, and subsequently to such degree as will protect the granulations from any infectious matter which may enter or form in the wound. Irrigate the wound after the operation with bichloride solution, 1–2000; remove every particle of dead tissue; apply drains to every recess which will retain fluids, and close the wound with sutures to the fullest extent practicable. Apply iodoform dressings covered with bandages of bichloride or carbolized gauze, and finally two or three layers of plaster-of-Paris bandages. Redress at intervals of several days, or only when there are indications of disturbances in the wound.

BONES AND JOINTS OF THE UPPER EXTREMITIES.

Resection is to be preferred to amputation, in the greater number of lesions of the upper extremities, as the principal function is that of mobility.[1]

The phalanges may be resected in part or whole, but the results are not always favorable, owing to the stiffness, shortening, and deformity which so often follow. Efforts should be made to preserve the periosteum with a view to the production of new bone in the shafts of the bones that have been removed. In the after-treatment, apply a splint to the palmar surface, and make such extension as will maintain the full length of the phalanx: The entire phalanx is removed by an incision over the shaft of the bone on the side; the tendons being raised, introduce the bone forceps, divide the bone, and remove the two halves separately at their articulation. In removing the third or ungual phalanx, make on the palmar surface a double **T** incision, one end corresponding to the articulation, the other to the extremity of the finger; denude the phalanx from the end towards its base, the nail remaining intact. The shaft of a phalanx may be removed by a longitudinal incision made on the dorsal or lateral aspect of the phalanx; detach the tendons; with bone forceps, held at right angles to its long axis, divide the shaft in two places equally distant from its extremities, and remove the fragments.

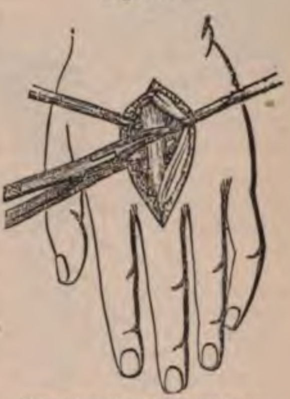
The metacarpal bones may now be resected antiseptically for shot injuries with far better chance of recovery than formerly. For diseases, the excision gives favorable results. The superficial condition of the dorsal aspect of these bones, and the important anatomical relations of their palmar surfaces, require that all operations for their excision be commenced on the posterior part or dorsum.

---

[1] C. Sédillot.

(*a*) The entire bone is removed as follows: Make an incision along the dorsal surface of the third and fourth metacarpal bones, and on the radial side of the second and ulnar side of the fifth; draw the extensor tendon on one side, and relieve the sides of the bone of the soft parts; separate the periosteum as much as possible, and divide the centre with the bone forceps (Fig. 189) or with the chain saw, the soft parts being protected by a compress or spatula; the fragments are then separately elevated, and disarticulated with the point of the knife.[1]

Fig. 189.



Resection of metacarpal bone.

This operation may be variously modified, according to the condition of the part affected. When there is much swelling, make a short lateral incision at each extremity of the longitudinal cut.[2] The incision may also be made between the tendons of the long and short extensors on the dorsum along the radial border.[3] In resection of the fifth metacarpal the cut may be a T or an L.[2]

(*b*) The shaft is removed by a longitudinal incision on the radial border of the first and second, on the ulnar border of the fifth, and the dorsal surface of the third and fourth; carefully avoid the extensor tendons, and with a chain saw divide at two points the denuded bones.

(*c*) The proximal portion of the bone is resected by a longitudinal incision over the upper extremity of the metacarpal bone; avoid the extensor tendon, separate the soft parts from the sides of the bone; divide the bone at the requisite point with bone forceps, or with the saw, after being isolated from the soft parts, and as far as possible from the periosteum; seize the fragment with the forceps; raise it from its bed (Fig. 190), and disarticulate the joint with the point of the knife.

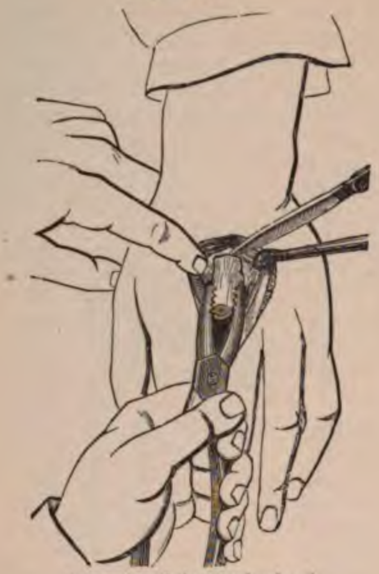
(*d*) In complete resection the extremity of the metacarpal bone is removed and its corresponding carpal bone, by a single longitudinal incision made in the superior extremity of the metacarpal bone, which is denuded of soft parts, and sawn at the proper point; remove this part at its articulation, and then extirpate the carpal bone.

(*e*) The phalangeal extremity of the metacarpal bone of the thumb is removed thus: Make an incision on its dorsal surface; draw aside the extensor tendons carefully; divide with a chain saw at the required point; seize the diseased portion with the forceps (Fig. 191), bring it forward, expose the articular extremity with the point of the knife by which it is readily disarticulated.

---

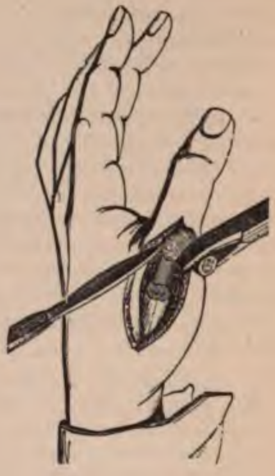
[1] E. Chassaignac. [2] C. Sédillot. [3] A. Guérin.

Fig. 190.



Resection of the proximal end.

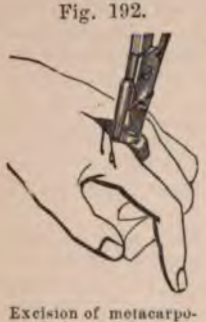
Fig. 191.



Resection of distal end.

Or, make an oblique incision, commencing half an inch beyond the point at which you wish to apply the saw, from the middle of the dorsal surface of the metacarpal bone to the commissure of the finger, then another from the same point to the next commissure on the other side; thus circumscribing a V-shaped flap, with its base next the finger; turn aside the extensor tendon, detach the interossii from the sides of the bone, and open the joint, cutting its anterior and lateral ligaments carefully, not to wound the flexor tendons; then dislocate the phalanx backwards.

Fig. 192.



Excision of metacarpo-phalangeal joint.

In total resection the incision should be dorsal, except[1] for the first, second, and fifth metacarpo-phalangeal articulations; in opening these the incision should be lateral, as the operator will thus avoid exposing the extensor tendons; the two articular surfaces being exposed, the ligaments are incised, and the bone either sawn with the chain saw, or divided with the bone forceps.

Or, make two incisions, beginning at the middle of the dorsal face of the metacarpal bone, diverging on either side to the commissure of the finger, and forming a V-shaped flap, with its base towards the finger.

The phalangeal joints should be excised by an incision along the side, slightly convex downwards; through a single incision the extremities of the bones may often be reached and excised by turning them outwards. In the treatment make sufficient extension by means of a palmar splint to keep the bones apart, and begin passive flexion as soon as repair is established.

The metacarpo-phalangeal joints should be excised by dorsal incisions along the margin of the extensor tendons, which must be drawn one side; the articular surfaces being cleared, excise them with cutting forceps, a fine saw, or chain saw (Fig. 192). The treatment is the same as after excision of the phalangeal joints.

---

[1] R. M. Hodges.

The wrist joint is properly limited to the articular end of the radius, and the first row of carpals. But excision at the wrist includes the removal, not only of the radius and first row of carpal bones, but of a part or whole of the ends of the radius and ulna, a part or whole of the carpus, the proximal ends of the metacarpal bones, or all of these at once.[1]

The radio-carpal articulation is formed between the radius and triangular fibro-cartilage above, and the scaphoid, semilunar, and cuneiform bones below; the carpal articulations are arthroidal; the synovial sacs are so arranged that their communications are limited; this anatomical peculiarity should be remembered in the effort to remove portions of the carpus, as it is desirable not to open these cavities farther than is absolutely necessary; the ligaments are dorsal, palmar, and interosseous.

In the radio-carpal and common carpal articulation, there is allowed not only flexion and extension, but a certain amount of lateral bending.[2]

The following are the definite end results after various excisions for shot injuries at the wrist.[3] In five complete excisions the functions of the hand were much impaired, but preferable to amputation; in four excisions of the extremities of radius and ulna, there was lateral distortion of hand and stiffness of fingers; in twenty-one excisions of the lower end of the radius nearly all had anchylosis and extreme deformity; the hand, generally, was strongly deflected to the radial side, often at right angles, the fingers rigidly fixed in flexion or extension, the end of the ulna projecting, and the integument over it irritated and exposed to accidental injuries. In fourteen excisions of the ulna, nearly all had anchylosis and deformity, the hand was generally less displaced, but there was an equal proportion of cases of rigidity of the fingers, and more examples comparatively of paralysis and of neuralgic suffering. In six cases of excision of the end of the radius with one or more carpals, there was anchylosis and deformity. In eight cases of excisions of the end of the ulna with adjacent carpals, or carpals and metacarpals, two had very useful hands, but the remainder had anchylosis, contracted fingers, and other deformities. In eight excisions confined to the carpus, three retained valuable mobility of the hand, and five had anchylosis with much deformity. From this record it seems probable that recovery unattended by anchylosis is seldom to be anticipated, yet that this result is not disastrous provided the hand is in good position, and the functions of the fingers are in some degree preserved. But these imperfect extremities are far more useful, especially when supported by suitable apparatus, than stumps after amputation.[4]

Excision for caries has hitherto been unsuccessful chiefly owing to the recurrence of the disease, and the impaired functions of the hand; but these results are largely due to partial excisions, and hence the necessity of complete removal of the wrist when affected with caries. Even bones which appear sound in a carious joint seem apt to be affected in an insidious, incipient degree, and if left behind may lead to recurrence of the complaint.[5]

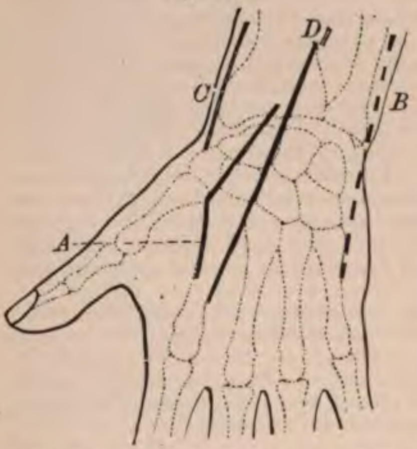
The indications for excision are: for shot injuries, if there is comminution of the bones of the carpus, or of the carpus and epiphyses of the bones of the forearm, especially if the missile is lodged, and cannot be removed otherwise; if subsequently infiltration cannot be controlled by incision and threatens to spread to the forearm;[6] in injuries, as compound dislocations, all displaced and fractured bones which must eventually become detached should be at once removed; in crushing injuries when vessels, nerves, and soft parts are not so much involved as to render amputation necessary; in secondary excisions for injuries to the carpus the entire wrist should be removed; in caries involving the carpus extensively, and which has resisted other treatment, excision becomes necessary.

---

[1] R. M. Hodges.
[2] Quain's Anat.
[3] G. A. Otis.
[4] E. D. Hudson.
[5] J. Lister.
[6] Von Langenbeck.

Excision of the entire wrist consists of a series of operations each of which must be executed with scrupulous care, as follows:[1] Break down adhesions of tendons by freely moving all the articulations of the hand; commence the first incision at the middle of the dorsal aspect of the radius *A* (Fig. 193), on a level with the styloid process; carry it towards the inner side of the metacarpo-phalangeal articulation of the thumb, running parallel in this course to the extensor secundi internodii; on reaching the line of the radial border of the second metacarpal bone, carry it downwards longitudinally half the length of the bone, the radial artery lying farther to the outer side of the limb; detach the soft parts from the bone at the radial side of the incision, the knife being guided by the thumb-nail; divide the tendon of the extensor carpi radialis longior at its insertion into the base of the second metacarpal bone, and raise it along with that of the extensor carpi radialis brevior previously cut across, and the extensor secundi internodii while the radial is thrust somewhat outwards; separate the trapezium from the rest of the carpus by cutting forceps applied in the line with the longitudinal part of the incision; leaving the trapezium in position until the rest of the carpus is taken away, dissect the soft parts on the ulnar side of the incision from the carpus as far as convenient, the hand being bent back to relax the extensor tendons of the fingers; commence the second incision, *B* (Fig. 193), at least two inches above the end of the ulna, immediately anterior to the bone, and carry it downwards between the bone and flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone on its palmar aspect; raise the dorsal lip, cut the extensor carpi ulnaris at its insertion into the fifth metacarpal bone, and dissect it from its groove in the ulna without isolating it from the integuments; separate the extensors of the fingers from the carpus, and divide the dorsal and internal lateral ligaments of the wrist-joint; leave the con-

Fig. 193.



Excision of wrist. *A*. Lister's radial incision. *B*. Lister's ulnar incision. *C*. Ollier. *D*. Von Langenbeck.

---

[1] J. Lister.

nections of the tendons with the radius undisturbed; now clear the anterior surface of the ulna by cutting towards the bone, avoiding the artery and nerve; open the articulation of the pisiform bone, and separate the flexor tendons from the carpus, the hand being depressed to relax them; clip through the base of the process of the unciform bone with pliers, but avoid carrying the knife farther down the hand than the bases of the metacarpal bones; divide the anterior ligament of the wrist-joint, separate the carpus from the metacarpus with cutting pliers, and extract the carpus with sequestrum forceps through the ulnar incision, dividing any ligamentous attachments; the articular ends of the radius and ulna may be protruded at the ulnar incision and excised; divide the ulna obliquely with a small saw so as to take away the cartilage-covered rounded part over which the radius sweeps while the base of the styloid process is retained; clear the radius sufficiently to remove the articular surface; if the caries is slight, remove a thin slice without disturbing the tendons in their grooves on the back of the bone; clip away the articular facet of the ulna with bone forceps applied longitudinally; if the caries is extensive, remove freely all the diseased bone with pliers and gouge; examine the metacarpal bones and excise the articular surfaces only if they are sound, and more extensively if diseased; next seize the trapezium with strong forceps, and dissect it out without cutting the tendon of the flexor carpi radialis, and excise the end of the metacarpal bone; clip off the articular facet of the pisiform bone, and, if sound, leave the remainder in position; close the radial incision firmly throughout with sutures, and also the ends of the ulnar incision; but the middle must be kept open by pieces of lint introduced lightly to give support to the extensor tendons, and afford free escape of discharges.

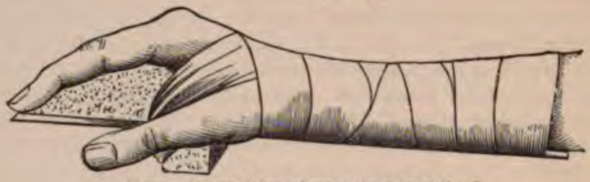
The incision[1] may be made from the middle of the ulnar border of the metacarpal bone of the index finger upwards to the middle of the dorsal surface of the epiphyses of the radius *D* (Fig. 193), crossing to the ulnar side of the extensor carpi ulnaris at its insertion into the base of the third metacarpal bone, and dividing the dorsal ligament of the carpus between the tendons of the long extensor of the thumb, and the extensor indicis; the soft parts being raised through this incision by careful manipulation of the hand, the carpal bones may be removed one by one, by dividing the ligaments which bind them together and to other bones; or make an incision, *C* (Fig. 193),[2] from an inch below the styloid process of the radius, upwards along the external border of that bone, to a sufficient extent; a branch of the radial nerve being preserved, the extensor tendons of the thumb are exposed and drawn aside, and the insertion of the superior longus exposed. With a periosteotome detach the tendon of the supinator, with the periosteum denude the end of the radius, bend the carpus forcibly inwards, dislocating the head of the radius outward. After separating the fibrous attachments excise the requisite amount. The end of the ulna may be reached through the same wound, or an incision along the inner border will expose it.

The after-treatment[3] must be pursued with due recognition of the fact that the new joint at the wrist is produced by an approximation of the bones of the forearm and of the metacarpus, partly by shortening of the limb and partly by the growth of new bone from the divided ends; with proper care, perfect symmetry of the hand can

[1] Von Langenbeck. [2] L. Ollier. [3] J. Lister.

always be insured; for as the radius and ulna above, and the metacarpus below, are divided in parallel lines, the shrinking of the new material between them draws the hand equally upwards towards the forearm; the surgeon should aim to maintain flexibility of the fingers by frequently moving them, and at the same time to procure firmness of the wrist by keeping it securely fixed during the process of consolidation. These indications are met by placing the limb on the splint (Fig. 194), which consists of an obtuse-angled piece of thick cork attached to a splint, with a cross-bar of cork attached to the under surface about the level of the knuckles; on the splint the hand lies semi-flexed, its natural position, the fingers midway between the extremes of flexion and extension into which it is necessary to bring them in the daily passive movements; the thumb is to be kept from the index finger by a pad of cotton maintained between them; flexion and extension of the fingers should be commenced on the second day whether inflammation has subsided or not, and continued daily, each finger being flexed and extended to the fullest degree possible in health, care being taken that the metacarpal bone concerned is held steady; pronation and supination must not be neglected, and as the wrist acquires firmness, flexion and extension, adduction and abduction, should be occasionally encouraged; passive motion must be continued until there is no longer a tendency to contract adhesions.[1]

Fig. 194.



Hand after excision of wrist, laid in splint.[1]

The radius may be resected for necrosis with excellent results, the mortality being small, and the usefulness of the hand and wrist being well preserved. In shot injuries operative interference increases the mortality, unless the antiseptic method is followed. In the after-treatment secure rest by a wire, tin, or sole-leather splint applied to the inner surface of the arm and forearm, and use iodoform dressings.

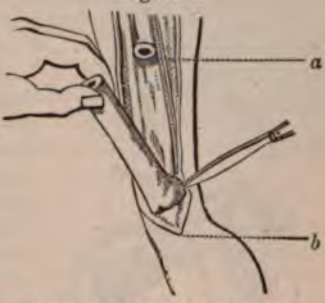
(*a*) The lower extremity is broad, of a quadrilateral form, having two articular surfaces, one concave, on the lower part, for articulation with the scaphoid and semilunar bones; the other on the inner side, narrow and concave, to articulate with the lower end of the ulna.

The anterior and posterior ligaments are attached to the margin of the joint, the lateral ligament to the styloid process; the posterior surface has grooves for the passage of the tendons of extensor muscles; the outer surface of the styloid process has grooves for tendons, and its base gives attachment to the supinator longus muscle; the pronator quadratus muscle occupies the lower fourth of the anterior surface.

---

[1] J. Lister.

Fig. 195.



Resection of lower end of radius.

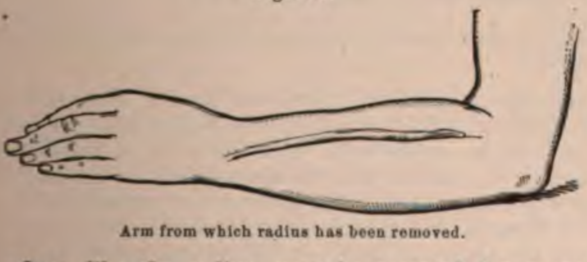
Resect as follows: Make a longitudinal incision along the radius on its external anterior border (Fig. 195), extending downwards to a point opposite, and a little behind, the styloid process (*b*); if necessary, add two terminal incisions at the extremities of the first one, extending transversely backwards, about three-quarters of an inch; dissect so as to expose the bone on its different aspects; make section of bone by means of the chain-saw; separate the diseased portion from the soft parts, and isolate the lower part of the radius from its attachments at the radio-carpal articulation, without injury to the artery (*a*), nerves, or tendons. In many cases it will suffice to make a simple straight incision along the radial border, over the part parallel with its long axis.

(*b*) The shaft is resected thus: Make a long straight incision on the external aspect of the bone, parallel with its shaft; separate the muscles, and, drawing the lips of the wound apart, denude the bone; pass the chain-saw, divide the bone at the two points selected, and raise the fragment from its bed.

(*c*) The head of the radius is quite superficial on its posterior part and surrounded by the orbicular ligament, which retains it in the lesser sigmoid cavity of the ulna. Resect by making a straight incision on the posterior and external part of the arm over the bone, divide the bone cautiously, and raise it from its articulation by cutting the ligaments with the point of the knife.[1]

(*d*) The entire radius may be excised; make an incision along the outer surface of the radius from the styloid process to the head of the bone at the elbow-joint; divide the fascia along the outer border of the supinator longus muscle, and separate the muscles along this line down to the bone; incise the periosteum the length of the wound, and separate it from the bone; divide the bone in the middle and remove each extremity separately (Fig. 196).

Fig. 196.



Arm from which radius has been removed.

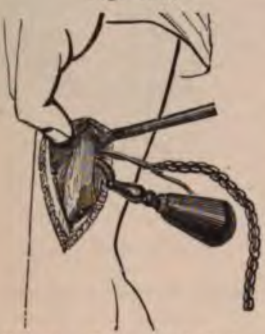
The ulna, like the radius, may be resected for necrosis with very favorable results, both in regard to mortality and usefulness of the limb; but for shot injuries the mortality is in the aggregate augmented by operative interference,[1] except when antiseptics are employed. The after treatment is the same as in resections of the radius.

---

[1] L. Ollier.

(*a*) The lower extremity articulates on its external surface with the radius, but is excluded from the wrist-joint; it has an anterior and posterior ligament uniting it to the radius, and a lateral ligament connecting the styloid process to the carpus. Resection is as follows: the hand being carried outwards, make a longitudinal incision over the most superficial part of the extremity; dissect the periosteum from the bone to the required height, and carry the chain-saw under the bone (Fig. 197); having divided the bone, proceed to dissect it from its articular connections.

Fig. 197.



Resection of lower end of ulna.

(*b*) The shaft may be removed by a longitudinal incision on its posterior part, parallel with the bone, and external to its border; separate the muscles, detach the periosteum, make a section of the bone at two points selected, and remove the included portion.

(*c*) The upper extremity includes the olecranon which enters largely into the formation of the elbow-joint, but is subcutaneous. Resection is as follows:[2] make a longitudinal incision, five inches in length, over the middle of the olecranon, extending three inches above and two below it, penetrating to the bone; divide the triceps tendon at its insertion towards either edge, care being taken to avoid cutting across the aponeurosis, which is continuous from the edges of the tendon over the muscles lying on the posterior part of the forearm, and inserted into the edges of the olecranon; dissect up these insertions of the fascia, as well as the origins of the muscles beneath it, from the bone to the extent of nearly two inches, which allows the olecranon to be exposed, when the edges of the incision may be drawn asunder over the condyles, broad, curved spatulæ being used for this purpose; with the amputating saw cut through one-half the thickness of the bone; complete the section with a fine saw, after which separate completely with a chisel and mallet.[3]

In some cases better access is secured to the bone by a **T**, in others by a crucial incision.[4]

(*a*) The entire ulna may be removed by the following method:[5] Rotate the limb inwards from the shoulder-joint, and carry the pronation of the forearm so far as to cause the palm of the hand to look directly outwards; slightly flex the elbow-joint and elevate the hand; this twisted position places the ulna upon the posterior and outer aspect of the forearm and renders it more easily accessible; the limb thus placed, the assistants maintaining the arm and forearm steadily,

[1] G. A. Otis.

[2] G. Buck.

[3] S. D. Gross.

[4] A. Velpeau.

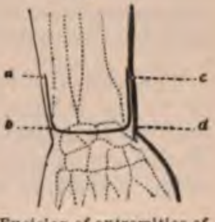
[5] J. M. Carnochan.

stand upon the right side of the patient, and with a strong, straight, sharp-pointed scalpel make an incision along the posterior and inner aspect of the ulna, commencing at the lower part of its superior third and extending downwards to a point over the extremity of the styloid process, dividing the tegumentary layer and fascia; pull back the tendon of the extensor carpi ulnaris and expose the bone; make a transverse incision, about an inch long, parting from the lower extremity of the first incision, across the back of the wrist; reflect the superficial tissues and detach the tendon of the extensor carpi ulnaris carefully from its groove on the lower part of the ulna; now carry the dissection along the anterior surface of the lower portion of the ulna, and detach the soft parts from the bone as far as the interosseous ligament, the ulnar artery and nerve being carefully avoided; detach the soft parts from the posterior surface of the ulna, avoiding injury to the extensor tendons; divide the bone at the lower part of the middle third, and separate the lower fragment from its articular connections; prolong the incision upwards, along the posterior surface of the ulna, terminating at the upper part of the olecranon, opposite its outer edge; to this join a terminal incision transversely across the back of the elbow-joint, as far as the inner margin of the ulna; now dissect the soft tissues from the bone, upon its posterior and anterior aspects, as far as the interosseous ligament, and as high up as the insertion of the brachialis anticus muscle; pass a knife, curved flatwise, close upon its interosseal margin, grazing the bone, and dividing the interosseal membrane upwards; the soft parts being held apart, and the interosseous and ulnar arteries protected, flex the elbow-joint now and open behind, by entering the knife close to the inner edge of the olecranon; divide the attachment of the triceps extensor by cutting directly outwards; protect the ulnar nerve; divide the lateral ligament and the attachments of the brachialis anticus muscle, the coronary ligament, and remove the bone from its articulation.

The radius and ulna may be removed together,[1] and if the periosteum remains a useful limb may result. Make a straight incision the entire length of each bone on the dorsal surfaces, separate the muscles, and when the bone is reached raise the periosteum and detach the articular extremities; keep the limb well extended during the after-treatment.

(*a*) The inferior portions are resected as follows (Fig. 198): The hand being pronated and held firmly upon some solid surface, make two longitudinal incisions along the borders of the radius and ulna, *a*, *b*, *c*, *d*; raise the soft parts on both surfaces, introduce the fine saw,[2] and after dividing, remove the extremities; if necessary, unite the lower extremities of these, *b*, *d*, and dissect the quadrilateral flap, *a*, *b*, *c*, *d*, thus circumscribed; turn the flap backwards and effect the disarticulation.

Fig. 198.



Excision of extremities of radius and ulna.

(*b*) The superior portions of both bones may be removed by lateral incisions, joined by a transverse incision over the joint; remove the radius first; denude the bone, and divide with the chain saw; the head is disarticulated by dividing the attachment of the biceps, and the orbicular ligament; divide the ulna in a similar manner, and disarticulate, carefully guarding against injuring the ulnar nerve on its inner aspect, and the artery in front, and preserving if possible the attachments of the brachialis anticus muscle.

---

[1] J. Lister.

[2] R. Butcher.

The elbow-joint has two motions, flexion and extension, which are limited to the locking of the coronoid and olecranon processes in the respective fossæ of the humerus which receive them; the path of motion is in nearly a vertical plane with a direction slightly outwards; the inner lip of the trochlea being prominent below, forms an expansion which corresponds to an inward projection of the coronoid part of the ulnar surface, and is only brought into use in flexion; the outer lip of the trochlea being everted at the upper and back part, forms a surface which is only in use in complete extension, and which then corresponds to a surface on the outer aspect of the olecranon, which comes in contact with no other part of the humerus; in flexion and extension, the radius moves by its cup-shaped head upon the capitulum, and on the groove between that process and the trochlea by a ridge internal to the cup.[1]

The usefulness of the joint after excision depends upon the perfection of the hinge, or antero-posterior motion. The extreme conditions in which it may be left are anchylosis, and a flail-like, or dangle-joint action. Though in both cases the limb is often very useful, yet every effort should be made to avoid such results. While it is true that after-treatment has much to do with the prevention of anchylosis, yet, in general, the extent of exsection determines the degree of mobility, and also the power of controlling it; if too little is taken away there will be more or less complete anchylosis, and if too much, there will be such relaxation of the muscles as to prevent their efficient action; excisions which have given the best results have been at the commencement of the condyloid projections of the humerus, and at the base of the coronoid process of the ulna.[2] The periosteum should be carefully preserved, whatever method is adopted. It may be established as a rule, that excision for injury should be partial and conservative, and for disease it should be entire, or limited only by the removal of the diseased bone.[2]

When the disease or injury is limited, it is of doubtful propriety to inflict additional injury by section of healthy bones, for excellent results have been obtained when the joint ends of either the upper or forearm have been removed after complete exposure of the joint, and the uninjured portions of the articulation have been unmolested.[3]

The method of operation may be by an incision made longitudinally, or by the H,[4] the T,[5] the ⊢, the ⊣, the + shaped. The results, both as to mortality and usefulness, prove that absolute preference should not be given to either method in all cases, but that the incision should be selected on anatomical grounds, or in relation to convenience, or facility of execution.[1] In general, the longitudinal incision, by giving sufficient exposure of the joint, and enabling the operator to avoid easily the transverse division of muscular attachments, ligaments, and fibrous structures, should be preferred.[2] Subperiosteal exsection is as follows: Make an incision (2, 2, Fig. 199)[3] three inches long on the posterior surface of the joint, a little internal to the middle of the olecranon, beginning about an inch above the tip of the olecranon, and extending an inch and a half or two inches above that point, upon the border of the ulna, and through muscle, tendon, and periosteum to the bone; with the elevator raise the periosteum of the ulna towards the inner side, and detach the inner half of the tendon of the triceps in connection with the periosteum, by means of short, parallel, longitudinal incisions; with the left thumb nail draw the soft parts which cover the internal condyle and inclose the ulnar nerve towards the epicondyle, and detach them by means of curved incisions until the epicondyle is entirely uncovered; the last incisions separate the origins of the flexor muscles and the internal lateral ligament, their connections with the periosteum being retained; now draw the outer portion of the triceps tendon outwards and separate it by short incisions from the olecranon, maintaining, however, its connections with the periosteum of the outer side of the ulna, which is raised from the bone with the insertions of the anconeus; by repeated incisions along the bone, loosen the fibrous capsule of the joint from the margin of the humerus, first over the trochlea, until the internal condyle appears; detach the external lateral ligament and origins of the extensor muscles, so that all remain in connection with each other and the periosteum; now forcibly flex the arm, protrude the articular surfaces through the wound, and saw them off; if the ulna is sawn off below the coronoid process, separate the upper fasciculi of the brachialis anticus without disturbing the union of the tendon with the periosteum.

---

[1] Quain's Anatomy.

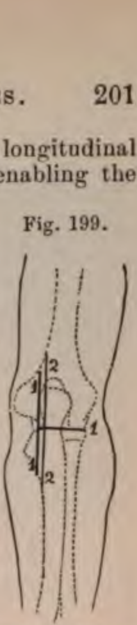
[2] C. Hüter; Von Langenbeck.

[3] G. A. Otis.

[4] Moreau.

[5] J. Roux.

Fig. 199.



Excision of elbow.

Other incisions may be made as follows: *B*, Ollier[4] (Fig. 200); *A*, Nélaton; *B*, *C*, Hüter (Fig. 201).

An osteoplastic operation[5] may be performed as follows (*A*, Fig. 202):[6] Make an incision from the end of the external condyle across the olecranon, then upward along the olecranon to a point an inch above its end; draw aside the ulnar nerve, and divide the olecranon; now expose the humerus and saw it off below the epicondyles; remove the head of the radius and reunite the olecranon with wire. An external incision, *B*, can be adopted.

Subperiosteal resection may be so performed as to retain the origins of muscles, as follows:[7] Make parallel incisions over the external and internal condyles, of proper length; raise the soft parts from the internal condyle, separate the attachments of the flexors with the lamellæ of bone, by means of a chisel; raise the periosteum on both surfaces with the elevator, and divide the lateral ligament; repeat the same operation on the external condyle; now divide the humerus above the condyles, separate the attachments of the triceps with periosteum and lamellæ of bone; detach the coronoid process from the ulna; divide the extremity of the ulna and remove it.

---

[1] H. Culbertson.

[2] Von Langenbeck; R. M. Hodges.

[3] Von Langenbeck.

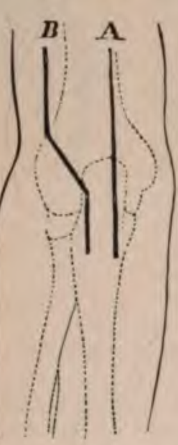
[4] Ollier.

[5] Von Bruns.

[6] Von Mosetig-Moorhof.

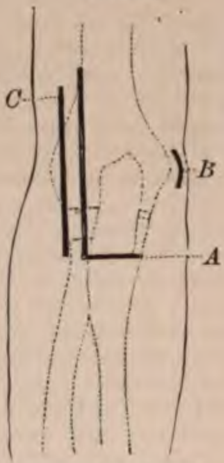
[7] Voigt.

Fig. 200.



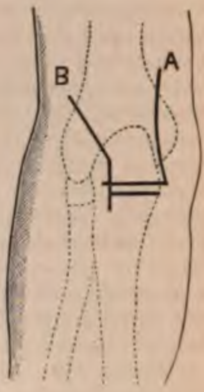
Methods of Van Langenbeck and Ollier.

Fig. 201.



Methods of Nélaton and Hüter.

Fig. 202.



Osteoplastic method. *A.* Von Mosetig-Moorhof. *B.* By external incision.

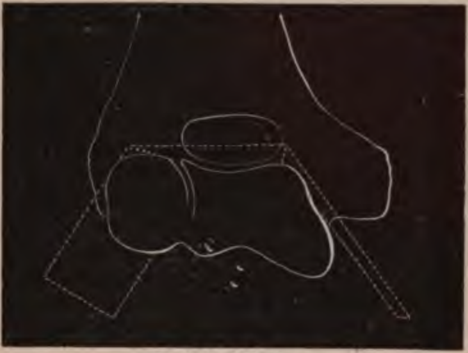
The ⊢ incision, 1, 1, 1 (Fig. 199), may sometimes be preferred; the arm being semi-flexed, make an incision three or four inches long on the inner aspect of the dorsal surface of the joint, commencing about two inches above the internal condyle, and external to the ulnar nerve, which must be carefully drawn inside when exposed; make a second incision at right angles, dissect up the two flaps to the requisite extent; remove the olecranon with strong cutting forceps and expose the interior of the joint; divide the lateral ligaments; detach the periosteum from the surface of the humerus; pass the handle of a scalpel under the bone, and saw upon it; turn back the fragment cut off, and detach it from the joint; separate the head of the radius from the neighboring soft parts, pass a compress under it, and cut it off, preserving all or part of the attachment of the biceps; then lay bare the ulna, prolonging downwards the internal incision; if necessary, isolate the portion to be cut off from the periosteum; put it aside from the soft parts with a compress or protecting guard, and saw it, preserving if possible the attachment of the brachialis anticus.

If the condyles are not diseased the hinge motion may be preserved by operating as follows:[1] After the median incision is made and the ulna cleaned, saw partly through this bone about an inch and a half from the olecranon, and complete the section with forceps; now dislocate the humerus backward and saw obliquely into the olecranon depression, first from the bed of the ulnar nerve, which is drawn to

---

[1] H. J. Bigelow.

Fig. 203.



Method of Bigelow.

one side, and similarly from the external condyle; break out the included mass (Fig. 203), divide the orbicular and lateral ligaments, dislocate the forearm backward, and saw off the radial extremity. The limb must be placed in a trough splint, semiflexed at the elbow, made of wire or tin, having a large fenestrum cut out at the joint to admit of easy access to the wound. The gypsum dressings may be applied with steel or iron bands curved at the joint so as to leave the wound perfectly free, and fastened above and below in the gypsum. Complete drainage must be secured by position and drain tubes, and iodoform dressings applied. As the cure progresses, passive motion must be early begun and persevered in until the cure is complete.

The humerus is generally resected in part, though it has been removed entire.

The mortality after resection for disease is comparatively small, but for shot injuries it is nearly double that in cases treated by expectant measures, and more than twelve per cent. higher than in a large series of primary amputations in the upper third of the arm.[1] The results of resection for disease are highly favorable as regards the functions of the limb, new bone rapidly forms and the shaft is firmly consolidated; for shot injuries the repair is much less perfect, as no bony union took place in upwards of twenty-seven per cent. of the recovered cases.[1]

The resected limb should be placed in a gypsum splint adapted to the shoulder, arm, and elbow, and inclosing the limb, except along the course of the excision; make such extension as will maintain the proper length of the new-formed bone.

(*a*) The lower extremity of the humerus presents on its anterior and posterior surfaces depressions for corresponding prominences on the ulna; the articular surface is on a lower plane than the condyles, and the inner part descends lower than the outer.

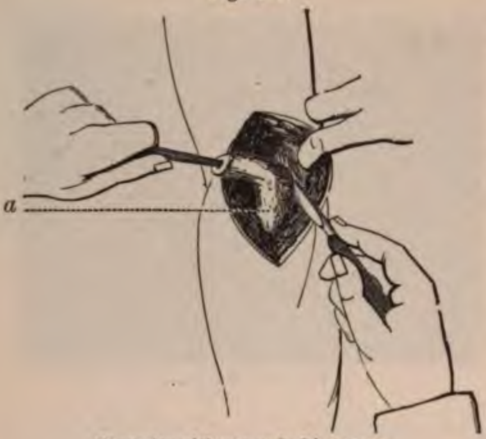
The flexor and extensor muscles of the hand arise from its condyles; it has anterior, posterior, and lateral ligaments; the brachial artery lies in front, and the ulnar nerve passes over the inner condyle on its posterior and external part.

Resect as follows: Make a straight incision on the posterior and external part of the arm (Fig. 204) sufficiently extensive to give a free exposure of the bone, *a*, when the wound is separated; denude the bone and divide with the chain saw; raise the cut end with the left

---

[1] G. A. Otis.

Fig. 204.



Resection of lower end of humerus.

hand, or with forceps, and proceed to disarticulate with the point of the knife, carefully avoiding the brachial artery in front, and the ulnar nerve behind and at the inside.

(*b*) Resection of the shaft requires the utmost care to avoid wounding the musculo-spiral nerve.

The lower half of the shaft of the humerus is closely invested with muscles, as the brachialis anticus and triceps; the upper half gives attachment principally to the muscles from the shoulder, chest, and back, as the deltoid, pectoralis major, latissimus dorsi, and rotators; the brachial artery, with the median and ulnar nerves, passes along the posterior margin of the biceps muscle, and the superior profunda artery and musculo-spiral nerve wind around the posterior and external part of the upper and middle portion of the shaft.

If the upper portion of the shaft is to be removed, make a straight incision on the external part of the deltoid muscle, care being taken not to extend the incision upward so as to involve the circumflex artery and nerve; when the lower part of the shaft is excised the incision should be along the outer border of the brachialis anticus muscle, avoiding the musculo-spiral and external cutaneous nerves; the bone is readily exposed and removed to the required extent.

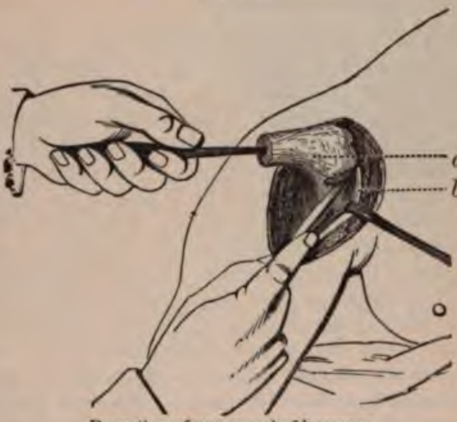
(*c*) The upper extremity consists of the head surrounded by the capsular ligament, the tuberosities and shaft.

The subscapularis is inserted into the lesser tuberosity; the supra and infraspinatus and teres minor into its greater tuberosity; the long head of the biceps runs through the capsule; the deltoid covers the external surface of the joint.

Resect thus: Make a straight incision, commencing a little above and outside of the coracoid process, and half an inch below the clavicle, and carry it downwards to the requisite extent along the deltoid muscle on the anterior part of the joint; the bone is here quite superficial, and is most readily exposed; the bicipital groove being found, dislodge the long head of the biceps muscle and draw it aside (Fig. 205, *b*); divide the tendons of the subscapularis, supra- and infraspinatus, and teres minor—as they are made tense by rotation of the bone outwards and inwards; open the capsule and resect.

If the disease is limited to the head of the bone, the diseased structures may possibly be removed with the gouge, without involving parts beyond the capsule; if it is of greater extent, or if the operation is undertaken for fracture

Fig. 205.



Resection of upper end of humerus.

involving the upper part of the shaft, expose the bone at the proper place and divide with the chain saw; elevate the upper extremity, and disarticulate with the point of the knife. It is not advisable to remove merely the articular surface of the humerus by an oblique incision, but the whole head must be removed at the surgical neck.[1] In the various conditions which injuries create, other methods may be preferable, namely, a V incision,[2] having its base upwards, or a triangular flap[3] on the external part of the deltoid;[4] or a semicircular incision, commencing at the posterior margin of the acromion, and passing downwards and forwards five inches, and opening into the articulation above and behind; and, finally, a U-shaped incision which includes the deltoid, isolation being effected with a spatula.[5]

(*d*) The entire humerus has been extirpated. In every case the thickened periosteum must be left in the wound, and the length of the limb preserved in order to the formation of new bone on which the usefulness of the extremity will depend. If no new bone forms the patient may have a useful arm supported by a ball-and-socket apparatus from the shoulder.[6] The incision must be the same as for the resection of the upper and lower extremity, avoiding carefully the musculo-spiral nerve.

The shoulder-joint consists of the large and hemispherical head of the humerus, opposed to the much smaller surface of the glenoid cavity of the scapula; the bones are not retained in position by the direct tension of strong ligaments, which would have too much restricted the movements, but by surrounding muscles and atmospheric pressure; the ligaments are the capsular, which invests the joint, the coraco-humeral, a broad bundle of fibres extending over the upper and outer part and attached to the root of the coracoid process, and the glenoid, which surrounds and deepens the articulation; the function of the joint is to give support to the arm and great freedom of movement, which is restricted only superiorly and posteriorly by the margin of the acromion.

The amount of motion is generally very satisfactory, but is not greater than that after recovery with anchylosis; the arm cannot be elevated beyond the horizontal line, and in many cases hangs down without any power in the deltoid; but the movements of flexion, extension, and adduction are generally free, and there is usually sufficient power in the forearm to carry heavy weights and perform many of the ordinary domestic tasks; recovery with anchylosis, therefore, gives as favorable results as regards the usefulness of the limb as the most successful excision.[1]

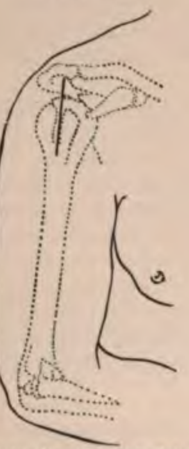
---

[1] C. Heath.
[2] Sabatier.
[3] J. Syme.
[4] F. Stromeyer.
[5] J. E. Erichsen.
[6] T. Billroth.

The indications for excision are: In caries, when a cure by natural processes has failed to follow judicious treatment, either from the extent of the disease in the bone, or the general feebleness of the patient's powers;[2] in compound dislocation;[3] in compound fracture with protrusion of the shaft through the wounds, and rupture of the capsule with destruction of the periosteum;[4] in extensive shot injuries, as the impaction of a ball in the head of the humerus, or comminution of the epiphysis.[5] The method of operation has a marked relation to the usefulness of the limb, *e. g.*, the longitudinal incision gives 8 per cent. perfect, and 45.6 per cent. useful limbs; the various other incisions give but a fraction over 1 per cent. perfect, and at the highest 11 per cent. useful limbs.[1] The straight incision should, therefore, be preferred in ordinary excisions. Subperiosteal excision of the humerus should, as far as possible, be practised in order to secure greater length of limb, for while the degree of shortening ordinarily bears a certain relation to the extent of bone excised, in subperiosteal exsections this law does not hold good, the shortening being comparatively vastly less in the latter, *e. g.*, 3.93 inches removed with periosteum gave 3 inches shortening, while 4 inches removed, subperiosteal, gave only one-half an inch shortening.[6]

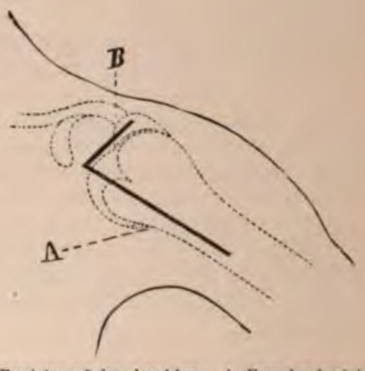
Exsection may be performed by the methods already given (p. 205), or as follows:[7] The patient lying on the back, the shoulder raised on a cushion, and the external condyle looking forward, make an incision commencing at the border of the acromion near the clavicular articu-

Fig. 206.



Excision by straight incision.

Fig. 207.



Excision of the shoulder. *A.* Regular incision. *B.* Supplementary.

---

[1] T. Holmes.
[2] T. Bryant.
[3] F. H. Hamilton.
[4] E. Chassaignac.
[5] G. A. Otis; Von Langenbeck.
[6] H. Culbertson.
[7] H. Von Langenbeck.

lation, and carry it directly downwards through the deltoid muscle to the capsule and periosteum (Fig. 206); draw aside the margins of the wound with retractors, and recognize the tendon of the long head of the biceps; run the point of the knife along the outside of the tendon, opening the groove and capsule to the acromion; draw the tendon one side, and while the arm is rotated outward, with a circular sweep of the knife, held perpendicularly to the bone, divide the capsule and the attachment of the subscapularis to the lesser tuberosity; then rotate the arm inwards, and in the same manner sever the capsule and the insertions of the supra- and infra-spinatus and teres minor from the greater tuberosity; the head of the bone is now thrust out of the wound and removed by a narrow back saw passed behind it. Any portion of the glenoid cavity may be exsected through this wound. If larger space is required, the incisions may be such as to completely expose the joint and parts adjacent,[1] *A*, *B* (Fig. 207).

Sub-periosteal resection may be effected by this method as follows: Divide the periosteum along the incision and raise it from the bone, first on the inside while the arm is rotated outwards, detaching with it the insertions of the subscapularis; then on the outside, while the arm is rotated inwards, separating the insertions of the external rotators; this part of the operation is difficult in primary resection owing to the thinness of the periosteum; the head of the bone being now exposed it may be turned out and excised.

The treatment consists in fixing the arm upon the triangular cushion, and applying iodoform dressings and inserting a suitable drainage-tube; in primary exsection the tube may pass out of an opening made posteriorly, the wound itself being firmly closed by sutures.

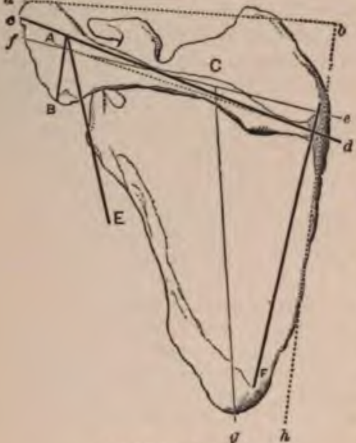
The scapula is resected for shot injuries, necrosis, and morbid growths. For shot injuries it is sometimes necessary to excise undetached portions of bone to facilitate the extraction of foreign bodies, and when there is great comminution it may be advisable to excise considerable portions of bone; there may be conditions also resulting from lacerations of large projectiles which would render primary extirpation of the scapula advisable; but as a rule it is better to wait, after removing detached fragments, the efforts of nature to consolidate the fractured bone, and to resort to resection as an intermediary or secondary measure in cases of extended necrosis.[2] Resection for necrosis should involve extirpation of the entire bone, when the disease is very extensive, as it is unsafe to leave portions of a flat bone thus affected.[3] Extirpations of the entire scapula for morbid growths have proved so successful as to render it a legitmate operation.

The scapula gives attachment to a large number of muscles: to the internal surface, the sub-scapularis; to the external, the supra- and infra-spinatus; to the spine, the trapezius and deltoid; to the superior border, the omo-hyoid; to the vertebral border, the serratus magnus, levator anguli scapulæ, rhomboideus major and minor; to the axillary border, the triceps, teres major and minor; to the glenoid cavity, the long head of the biceps; to the coracoid process, the short head of the biceps, coraco-brachialis, and pectoralis minor; it articulates with the humerus and clavicle; the subscapular artery, the largest branch of the axillary, descends along the outer border.

[1] L. Ollier. [2] G. A. Otis. [3] S. Rogers.

(*a*) The body (Fig. 208) may be removed to a greater or less extent. Make three incisions, one along the spine, *c*, *d*, and the other two from its extremity; one upwards to *c*, and the other downwards to F; dissect the flaps from the supra- and infra-spinatus fossæ, saw through the root of the acromion, and denude the anterior and posterior surfaces of the bone; reverse the body of the scapula from within outwards, and divide the part at the proper point with the saw.[1]

Fig. 208.



Excision of scapula.

Or make a longitudinal incision extending from the superior to the inferior angle along the vertebral border, F, *b*, a second parallel incision extending from the neck of the acromion to the middle of the external border, A, E; a transverse incision unites these along the spine; dissect the flaps, detach the muscles posteriorly and anteriorly, and divide the bone with the chain saw or forceps.

For a tumor, make an incision commencing at the superior angle of the scapula in a direction obliquely downwards and inwards; a second incision five inches below the upper end of the first, having a curvilinear direction terminating about the same distance from its lower end; dissect the integuments towards the axilla and spine, detach the muscles, separate the acromion and the neck of the scapula, and remove the bone.[2]

(*b*) The spine, acromion process, and angles may be separately resected. The spine may be readily exposed, owing to its superficial position, by an incision made parallel to its border (*c*, *d*); if required, the incision may be curved downwards so as to raise a flap; the bone being denuded, the diseased portions may be removed with a strong cutting forceps. To resect the acromion[3] make a semilunar incision at the posterior part of the shoulder with the convexity downwards; pass the chain saw under the narrow part of the neck of the acromion, divide the bone at this part, and disarticulate; or make a crucial or T incision, or follow the track of sinuses which may exist. An angle of the scapula may be resected by a transverse, or a V, or a crucial incision over the part. In resection of a border, make the incision parallel with the part to be removed.

(*c*) The entire scapula is removed as follows:[4] Make an incision from the acromion process to the posterior edge of the scapula (*f*, *e*) and another from the centre of this one downwards (*C*, *g*); reflect the flaps thus formed, separate the scapular attachment of the deltoid, and divide the connections of the acromial extremity of the clavicle; to command the subscapular artery, divide and tie it without delay; next cut into the joint, and around the glenoid cavity, hook the finger under the coracoid process, so as to facilitate the division of its muscular and ligamentous attachments, then pulling back the bone forcibly with the left hand, separate its remaining attachments with rapid sweeps of the knife. The sub-periosteal resection may be made by the same incision.

---

[1] A. Velpeau. [2] S. D. Gross. [3] E. Chassaignac. [4] J. Syme.

The scapula may be removed by any of the methods given for the excision of a part of the body; other methods have been adopted, namely, a flap formed by the incision *a*, *b*, and *b*, *h*; or A, *d*, joined at the extremities by *b*, *d*, and A, E.

The clavicle has such immediate relations to the upper walls of the thoracic cavity that operations for its extirpation must be cautiously performed.[1] In shot fractures, detached splinters should always be immediately extracted; but extirpation of the bone for such injuries will seldom be required, though when the wound is uncomplicated by serious injury of the lung, nerves, or great vessels, it does not appear that the operation is necessarily fatal.[2] Necrosed bone should be cautiously removed in order not to injure neighboring parts. The removal of morbid growths involving the clavicle is sometimes the most serious operation in surgery.[1]

(*a*) The scapular extremity is broad and flat, and gives attachment on its posterior part to the trapezius, and on its anterior to the deltoid; it is bound to the acromion by a superior and inferior ligament, and to the coracoid process by the coraco-clavicular, or coracoid and trapezoid ligaments. Resection is as follows: make a crucial incision, of sufficient length; raise the flaps, cut the attachments of the deltoid and trapezius muscles and acromio-clavicular ligaments.[3] Or, make a curved incision, with its convexity forwards and a little outwards, which, reflected backwards, completely exposes the bone; divide with the chain saw, seize it with the forceps and divide the ligaments, raise the bone, and detach.[4]

For a tumor, make a crucial incision through the integuments and the platysma myoide,[2] one limb nearly in a line with the clavicle, and the other at right angles, and dissect the flaps and fascial coverings successively down to the external basis of the tumor; carefully detach the pectoralis and deltoid muscles from their clavicular origin, avoiding the cephalic vein, and divide on a director the fibres of the trapezius and the cleido-mastoid muscles. Disarticulate the scapular extremity of the bone, and the mobility thus communicated to the mass facilitates the completion of the operation; pass a director beneath the bone, as near to the sternal articulation as practicable, and with a pair of strong bone nippers divide it; detach the subclavius muscle and rhomboid ligament.[5] Or, make an elliptical incision from the middle of the clavicle backwards, over the most prominent part of the tumor.[6]

(*b*) The entire clavicle may be resected for necrosis: Make an incision parallel to its inferior border extending a little beyond its extremities; or add two vertical incisions, of one to two inches in length, one on the outside, the other on the inside of the first incision; the flap resulting from which divisions, on being raised up, completely lays bare the bone; then disarticulate either the sternal or acromial extremity, and grasp it with the left hand in order to raise it up,

[1] V. Mott.
[2] G. A. Otis.
[3] A. Velpeau.
[4] E. Chassaignac.
[5] B. Travers.
[6] J. Syme.

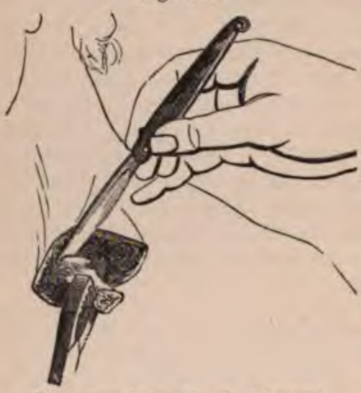
while with the right detach with the scalpel the attachments upon its lower border; or saw the bone through its middle, and remove the two halves separately.

For a tumor operate as follows: Make an incision from the acromial extremity of the clavicle to the external extremity of the clavicle of the opposite side; cross this by an incision at right angles with it, beginning just below the middle of the sterno-mastoid muscle, and extending to the face of the pectoralis muscle below the middle of the clavicle; dissect the four flaps from the surface of the tumor; dissect the deltoid muscle from its anterior edge, and the trapezius from its posterior edge, and divide the coraco-clavicular ligament; pass the chain saw and divide the bone; seize the fragment with the forceps, and detach the soft parts with the point of the knife, the edge being kept constantly turned towards the bone, in order not to make the slightest wound of the soft parts.[1]

(*c*) The sternal extremity is of a triangular form, and has the following relations:—

On its postero-superior surface to the sterno-mastoid and sterno-hyoid muscles, and on its anterior surface to the pectoralis major muscle; posteriorly it is in near relation with the pleura, internal mammary artery, subclavian vein, and transverse cervical artery; the innominata is on the right, and the thoracic duct on the left side.

Fig. 209.



Resection of sternal end of clavicle.

Resect as follows: Make (Fig. 209) an incision curved downwards, the degree of the curvature depending upon the size of the bone, but always so arranged as to enable the operator to raise it by dissection to the upper part; after raising the flap, instead of separating the muscles, pass a chain saw at the point where the bone is to be divided; remove the fragment by carefully disarticulating it with the point of the knife, and avoid wounding the important parts posteriorly.

For a large tumor, the following operation was performed: A semilunar incision, exposing the pectoralis major muscle, was made from the sterno-clavicular articulation, the extent of the tumor, and an incision was made from the outer edge of the external jugular vein, over the tumor, to the top of the shoulder, the platysma myoides and a portion of the trapezius divided, the bone exposed external to the coracoid process, and divided with the chain saw; another incision was made over the tumor from the sternal extremity of the clavicle to the termination of the first incision at the external jugular vein; in the subsequent dissection, owing to the large size of the tumor, the external jugular was tied, and the outer portion of the sterno-mastoid muscle was divided; the hemorrhage was excessive.[2]

---

[1] J. C. Warren.

[2] V. Mott.

BONES AND JOINTS OF THE LOWER EXTREMITIES.

The lower limbs are employed in support and progression, and hence resections should be so performed as to preserve stability of the bones.

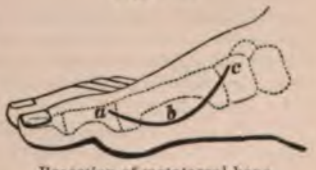
The phalanges of the toes may be resected by the methods given for the corresponding bones of the fingers. Resection of the shaft of a phalangeal bone may be by a straight incision on the dorsum, the extensor tendon being drawn aside; or the incision may be on the lateral surface of the joint and curved downwards; the bone may be divided with the forceps. The great toe is of the utmost value in progression, and in removing diseased bone from any part of it every effort must be made to retain periosteum, with a view to the preservation of its function.

The phalangeal joints should be exsected by incisions on the side of the joint, convex downwards. The treatment is the same as the similar operation in the upper limb.

The metacarpo-phalangeal joints should be excised by dorsal incisions along the extensor tendons, which must be preserved and drawn aside; the treatment is extension and passive flexion. The metatarso-phalangeal joint of the great toe may be removed by a lateral semilunar incision over the joint.

The metatarsal bones may be partially or entirely removed. (*a*) In resection of the phalangeal extremity of the metatarsal bones, make a straight incision on the dorsum of the toe, over the part to be removed, avoiding the extensor tendons, divide the bone with forceps or saw, and disarticulate; in operating upon the first and fifth, the incision may be upon the free lateral surface, and it may be straight or curved.[1] Resection of the extremity of the first metatarsal bone is made by an incision on the outside of the joint; denude the bone to the point at which it is to be cut and saw it perpendicularly to its axis; then detach it from the soft parts, proceeding from behind forwards and complete the resection by separating it from the phalanx. (*b*) In resection of the shaft of metatarsal bones, the same incisions are practised on this part of the metatarsal bones as at the extremities; in removing the body of the first and fifth, a curved incision more completely exposes the bone (Fig. 210); the chain saw should be used to divide the shaft of the first metatarsal bone. (*c*) The resection of the tarsal extremity of the metatarsal bones requires the same incisions as have been given for resections of the phalangeal extremities of the metatarsal bones. The chief obstacles in the disarticulation are the interosseous ligaments which unite the metatarsal bones together. The incision should freely expose the articulation, and the bone being divided, it should be raised with the forceps, and disarticulation effected with the point of the knife. (*d*) The resection of entire first and fifth metatarsal bones requires a curved incision with its convexity

Fig. 210.



Resection of metatarsal bone.

---

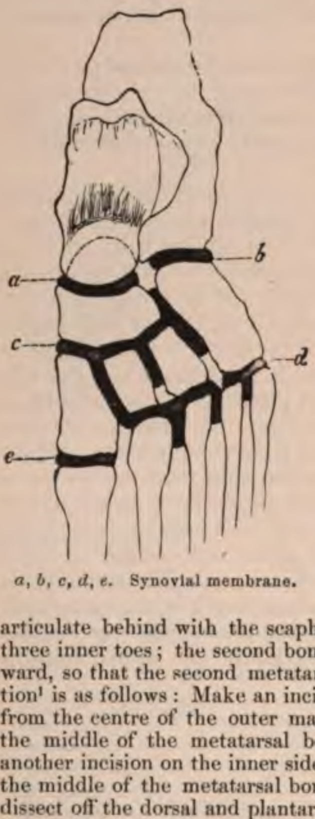
[1] E. Chassaignac.

downwards *a, b, c* (Fig. 210), and extending beyond the articulation; the bone being exposed, the middle of the shaft should be divided with the saw, and the fragments separately disarticulated. In the removal of the three middle metatarsal bones, a long straight incision should be made, the bone divided in its centre, and the operation completed as in the preceding case.

The metatarso-tarsal joints have been exsected with good results thus: make a semilunar incision on the dorsum of the foot and dissect the flap upwards; expose the first row of tarsal bones and exsect their surfaces with a saw; now expose the articular surfaces of the metacarpal bones and excise them.

The tarsal bones are very liable to be involved in the articular inflammations of that region, or to be separately affected by caries; in either case they may require removal, singly or in groups. The results have been in the highest degree favorable, both as to mortality and the usefulness of the limb. These operations have never been performed according to any prescribed rules, but each operator has adapted his incisions to the exigencies of the individual case in hand; in many cases the bones have not been resected entire, but the portion of bone diseased has been removed with a gouge. In the resection, care should be taken not to involve the synovial membrane of adjacent articulations, which do not communicate with the joint involved (Fig. 211); and, whenever practicable, the periosteum should be preserved. The individual bones may be exsected by the following methods, and by a combination of these incisions two or more bones may be removed at a single operation.

Fig. 211.



a, b, c, d, e. Synovial membrane.

The cuneiform or wedge bones are placed at the fore part of the tarsus; they articulate behind with the scaphoid, and in front with the metatarsals of the three inner toes; the second bone is the smaller, and does not reach as far forward, so that the second metatarsal is more deeply set in the tarsus. Exsection[1] is as follows: Make an incision on the outer side of the foot, extending from the centre of the outer margin of the plantar surface of the os calcis to the middle of the metatarsal bone of the little toe, 1, 1 (Fig. 212); make another incision on the inner side of the foot from the neck of the astragalus to the middle of the metatarsal bone of the great toe, 1, 1 (Fig. 213); carefully dissect off the dorsal and plantar surfaces from the outer and inner sides until the bones to be removed are completely exposed, the thumb of the left hand being the guide to the point and edge of the knife in keeping close to the surface of the bones, and avoiding injury to the important structures contained in the soft parts; insert between the soft parts and the bones a curved probe-pointed bistoury across the line of articulation between the astragalus, scaphoid, calcaneum, and cuboid, first upon the dorsal, then upon the plantar surface, and open up these joints; now introduce a keyhole saw between the plantar soft parts and the shafts of the metatarsal bones and cut them through, the handles of forceps or other body being inserted between the metatarsal bones and the dorsal soft parts to protect the latter. The wound must be dressed with iodoform gauze, or with naphthaline, and the foot supported with properly applied splints.

---

[1] P. H. Watson.

Fig. 212.

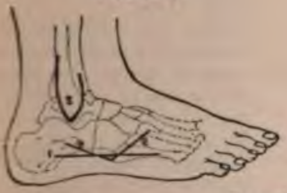
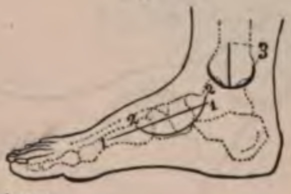


Fig. 213.



Resection of cuneiform bones.

The cuboid is situated on the outer side of the tarsus, wedged in between the os calcis and fourth and fifth metatarsal bones; internally it articulates with the third cuneiform equally with the scaphoid; the inferior surface is grooved for the tendon of the peroneus longus.[1] Exsect as follows: Make two incisions, 2, 2 (Fig. 212), one from the posterior extremity of the fifth metatarsal backward about two inches, the other of the same length from the same point along the dorsum inclining slightly forwards; raise this flap, and drawing aside the tendons of the peroneus longus and brevis, open the joints, and raise the bone with strong duck-bill forceps introduced from the free margin.

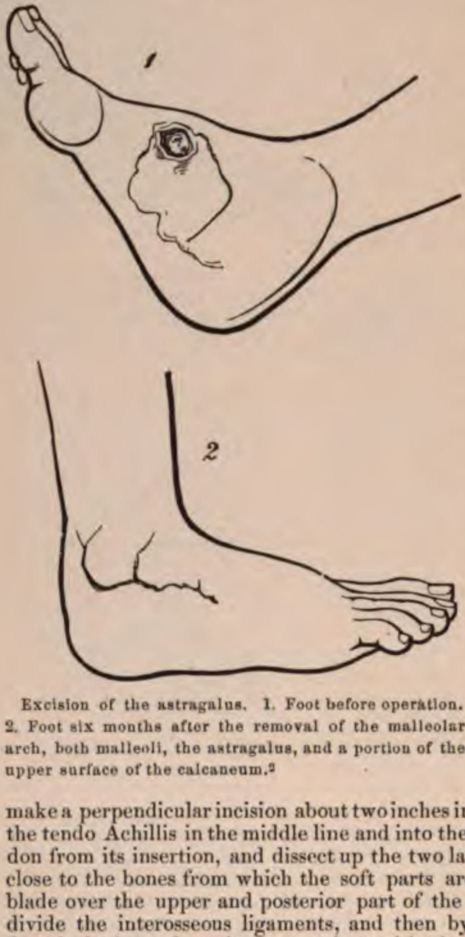
The scaphoid presents posteriorly a concave surface, as part of the socket of the head of the astragalus, anteriorly it has three facets for the three cuneiform bones, externally it has a small facet for the cuboid, and internally it presents a free surface having a small tubercle.[1] Exsect thus: Recognizing the tubercle, make a curved incision, the convexity downwards, extending from one inch posteriorly to the same distance anteriorly, 2, 2 (Fig. 213); raise this flap, and separate the soft tissues from both surfaces of the bone; with a strong knife separate the joints anteriorly and posteriorly; seize the bone with strong duck-bill forceps, raise and depress it, in the meantime detaching the ligaments with the knife.

The astragalus has most important connections; above it articulates with the tibia, laterally with the malleoli, and below with the calcaneum by two surfaces. It is attached to the calcaneum by the interosseous, posterior, and external ligaments; and to the scaphoid by a ligament passing from its anterior extremity. Excision may be made with slight injury to the tendons which pass over that region or by their destruction. The former methods are very tedious, but, unless sloughing occurs, give the best results. Excision is as follows: Make a superficial incision[2] from the tendon of the tibialis anticus, curved forwards and outwards to the middle of the scaphoid, thence backwards to a point below the external malleolus; raise the tendons and draw them aside, except the extensor brevis which should be cut; expose the bone, seize it with forceps, separate its attachments with the point of the knife, while the foot is strongly inverted. By the latter method, proceed as follows:[3] Make a curved incision from one malleolus to the other; lay the ankle-joint freely open, exposing the whole upper part of the diseased bone; sever the ligaments attaching it to the scaphoid; raise the bone with a lever, and divide the interosseous ligament uniting it to the os calcis; clear the back part of the bone carefully to avoid injury to the tendons and vessels which lie near. Or, in caries of the bone the incision may follow the direction of the external openings, 1 (Fig. 214). The results are very favorable, 2 (Fig. 214).

---

[1] L. Holden. [2] L. Ollier. [3] T. Holmes.

Fig. 214.



Excision of the astragalus. 1. Foot before operation. 2. Foot six months after the removal of the malleolar arch, both malleoli, the astragalus, and a portion of the upper surface of the calcaneum.[2]

The os calcis has been frequently removed, and with marked success, as regards the mortality; the part remains very useful for walking and standing.[1] The bone articulates above with the astragalus by two articular surfaces having an interosseous ligament; in front with the cuboid, to which it is firmly bound by four ligaments, two plantar, which are very strong, a dorsal and interosseous. Resection has been made by numerous methods, but the plantar flap (Fig. 215)[2] gives ready access to the bone, and removes the cicatrix from the plantar surface. The patient lying upon his face, make a horseshoe incision; carry it from a little in front of the calcaneo-cuboid articulation around the heel, along the sides of the foot, to a corresponding point on the opposite side; dissect up the elliptic flap thus formed, the knife being carried close to the bone, and thus expose the whole under surface of the os calcis; then make a perpendicular incision about two inches in length behind the heel through the tendo Achillis in the middle line and into the horizontal one; detach the tendon from its insertion, and dissect up the two lateral flaps, the knife being kept close to the bones from which the soft parts are well cleared; then carry the blade over the upper and posterior part of the os calcis, open the articulation, divide the interosseous ligaments, and then by a few touches with the point, detach the bone from its connections with the cuboid. Or, make an incision down to the bone from the inner edge of the tendo Achillis horizontally forwards along the outer side of the foot, somewhat in front of the calcaneo-cuboid joint, midway between the outer malleolus and the end of the fifth metatarsal; it should be on a level with the upper border of the os calcis; make a second incision vertically across the sole of the foot from the anterior end of the former incision to the outer border of the grooved or internal surface of the os calcis, 1 (Fig. 216). The results are usually very satisfactory, 2 (Fig. 216).

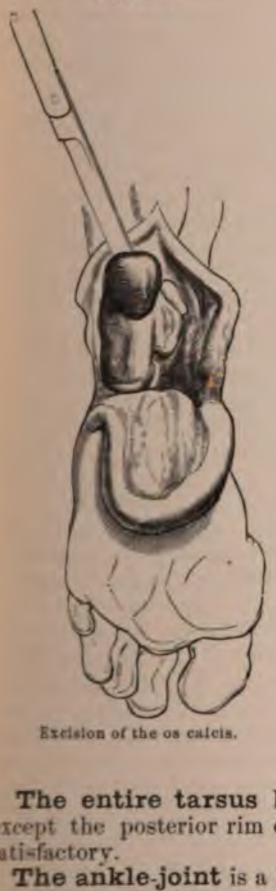
The tarsal joints generally become carious in connection with such extensive caries of the tarsal bones as necessitates the extirpation of entire bones. Single joints may be excised when the disease is limited, as the astragalo-scaphoid, *a* (Fig. 211), the calcaneo-scaphoid, the calcaneo-cuboid, *b*. The incision should be made over the affected joint and curved, and the articular surfaces should be removed with a fine saw or gouge.

---

[1] M. Polaillon.

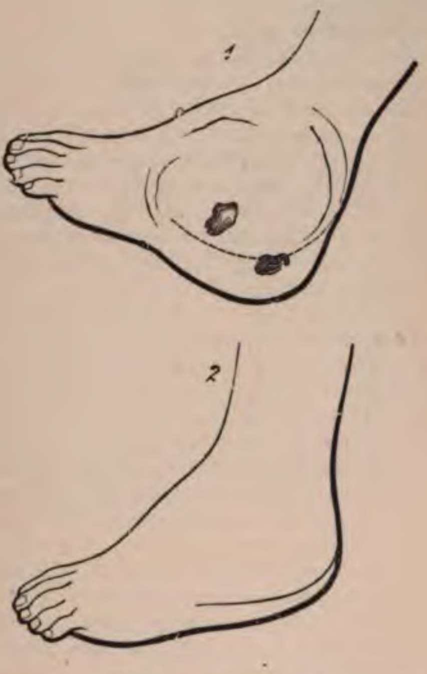
[2] J. E. Erichsen.

Fig. 215.



Excision of the os calcis.

Fig. 216.



Disease of the os calcis. 1. Foot before operation. 2. Foot after excision.

The entire tarsus has been removed[1] for tubercular osteitis, except the posterior rim of the os calcis. The result was not very satisfactory.

The ankle-joint is a hinge; the inferior extremities of the tibia and fibula united form a kind of arch which embraces transversely the superior articular surface of the astragalus so as to render lateral movements impossible when the ligaments are tense.[2]

The usefulness of the limb was recorded as follows: in excision for disease 5.5 per cent. were perfect, 60.1 per cent. useful, and in 12 per cent. the extremities were amputated; for injuries, 6 per cent. were perfect, and 59.3 per cent. were useful, for shot injuries 6 per cent. were perfect, 42 per cent. useful, and 6 per cent. were amputated, from which it is concluded that a large proportion of these excisions result in more or less usefulness of the limbs.

[1] W. T. Bull.

[2] Quain's Anatomy.

Excision of the ankle-joint is necessarily followed by anchylosis, which greatly cripples the limb. The indications for the operation are as follows: (*a*) In compound fractures and dislocations of the ankle-joint, with large, lacerated wounds, and protrusion of the bones, immediate excision greatly increases the chances of saving life and limb;[1] (*b*) in neglected compound fractures at the joint, originally produced by severe destruction, combined with extensive laceration of the ligaments, attended with suppuration, formation of fistulæ, partial dislocation, excision is the only remedy to produce rapid healing, and to gain a useful limb;[1] (*c*) in acute suppuration, due to osteo-myelitis, with abundant fetid discharge, and destruction of ligaments; (*d*) in cases which have recovered with so much deformity that the foot cannot be made useful with mechanical appliances;[1] (*e*) in chronic caries limited to the articulation of the tibia, fibula, and astragalus.[2]

The operation which best preserves vessels, nerves, and tendons, as well as the periosteum, is by two longitudinal incisions, one over the external and the other over the internal malleolus, and extended above and below sufficiently to give free access to all of the diseased bone.[3] All transverse incisions involving the vessels, nerves, and tendons should be avoided.[4]

Excise as follows:[3] The limb being turned on the inner side upon a firm pillow, make an incision two or three inches long on the middle of the fibula down to the point of the malleolus, and sufficiently deep to divide the periosteum; from the extremity of the malleolus continue the incision about a third of an inch, but merely through the skin, so as not to injure the tendons, but to permit of their being raised from behind the malleolus; at the point where the bone is to be divided, separate the periosteum with the raspatorium, and turn down as much as circumstances will permit; introduce the point of the index finger, or a spatula, into the interosseous space to protect the soft parts during the act of sawing; incline the saw slightly towards the joint, so that the part to be removed will be external at the point of division; seizing the upper extremity of the fragment with very strong forceps, separate its connections with the raspatorium and knife when necessary; now turn the foot upon the external surface, and make the same incision as upon the fibula; the periosteum is more easily separated than from the fibula; saw the tibia in place with a fine-bladed saw, when the parts are unyielding from chronic inflammatory infiltration; in recent injuries, and acute suppurations, it may be possible, after the periosteum has been separated and the ligaments incised, to gradually dislocate the foot outwards with the aid of the knife, and remove the tibia with the saw.[1] To gain more complete access in many cases, the incisions made along the centre of the malleoli may be extended laterally along the margins of the extremities of these bones, 3 (Fig. 218). Or, the same result may be attained by extending the incisions made along the posterior margins of the tibia and fibula, around the lower and anterior margins of the malleoli, 3 (Fig. 217). Remove the carious parts of the astragalus with a gouge in chronic disease; resect only in traumatic cases.

---

[1] R. Volkmann. [2] L. Ollier. [3] Von Langenbeck. [4] H. Hancock.

Modifications of the longitudinal incisions are as follows: Continue the external incision from the point of the malleolus downwards and forwards to within half an inch of the base of the outer metatarsal bone, making a flap; reflect this flap forward, expose and divide the fibula, and dissect out the fragment; now reverse the foot, and continue in like manner the internal longitudinal incision from the point of the malleolus to the projection of the inner cuneiform bone; reflect the flap, divide the internal lateral ligament close to the bone, and by twisting the foot outward the tibia and astragalus will appear at the wound; introduce a narrow-bladed saw between the tendons through to the external wound; saw off the end of the tibia and top of the astragalus.[1]

Fig. 217.

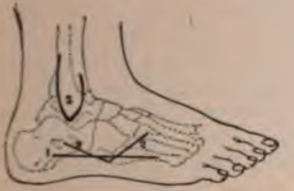
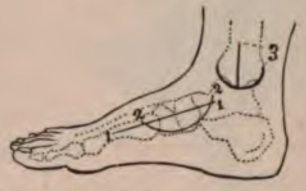


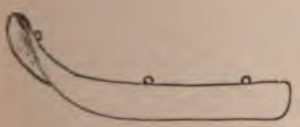
Fig. 218.



Resection of tarsal bones and excision of ankle-joint.

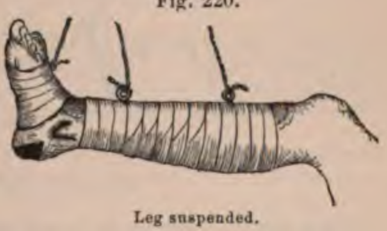
A convenient method of suspending the limb is as follows: Make a splint of wood or metal fitted to the anterior surface of the leg and ankle (Fig. 219), with rings inserted at three points for suspension; in its application, the splint is well padded and laid on the front part of the leg and the limb fixed in the ordinary bandage, the ankle being free (Fig. 220); or the gypsum bandage may be applied over the splint and around the leg, a layer of old flannel being first adapted to the leg, and the ankle left exposed.

Fig. 219.



Suspension splint.

Fig. 220.



Leg suspended.

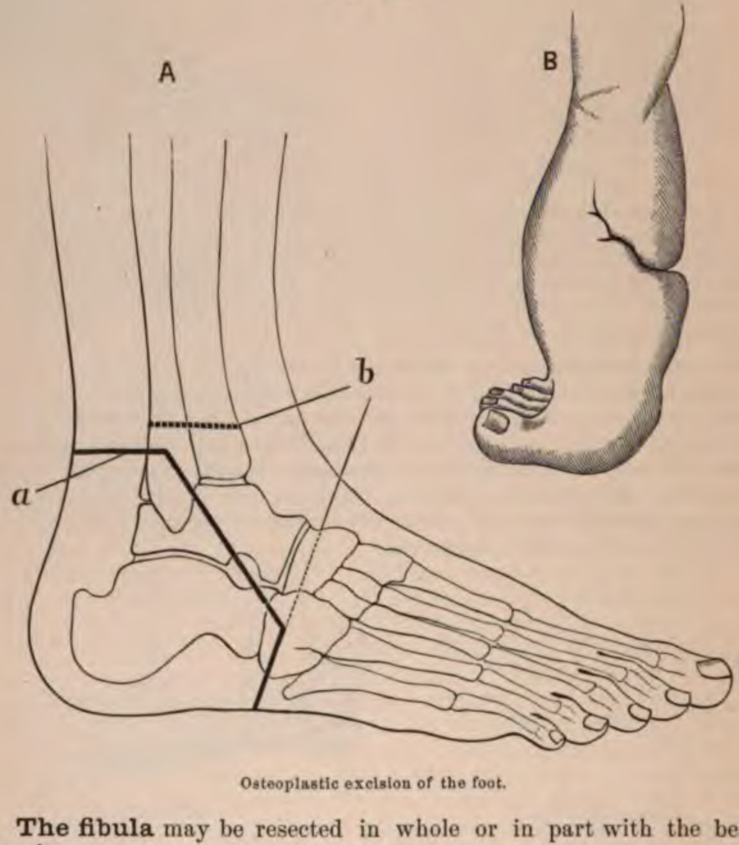
Osteoplastic excision of the ankle-joint[2] (Fig. 221, B) is as follows: Place the patient in a prone position, and make the following incisions down to the bone *A*: 1, across the sole of the foot from a point a little in front of the tubercle of the scaphoid to a point just behind the tuberosity of the fifth metatarsal bone; 2, from the extremities of this incision two incisions to the base of each malleolus; 3, a transverse cut joining the ends of these incisions, *a*; 4, flex the foot, divide the lateral ligaments, and open the joint from behind, separate the os calcis and astragalus from their attachments, and remove them at the medio-tarsal articulations. Remove with the saw the extremities of the bones of the leg at the base of the malleoli, *b*, and the articular surfaces of the scaphoid and cuboid. Attach the incised bones of the tarsus to cut surface of the tibia by wire, and apply the usual antiseptic dressings supported externally by gypsum bandages. The result is a talipes equinus (Fig. 221, B).

---

[1] H. Hancock.

[2] Mikulicz.

Fig. 221.



Osteoplastic excision of the foot.

The fibula may be resected in whole or in part with the best results.

(*a*) The lower extremity articulates through the malleolus externus with the astragalus; it also articulates with the tibia by a convex surface, the joint being continuous with that of the ankle.

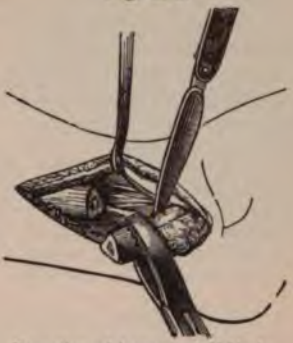
The ligaments are, the interosseous, which passes between the two bones, and is continuous above with the interosseous membrane; a flat triangular band extending between the two bones, anteriorly; the inferior ligament occupying the same position posteriorly; the transverse ligament extending from the external malleolus to the tibia.

Resect thus (Fig. 222): Make a straight incision over the bone the entire length of the diseased part; separate the periosteum, pass the chain saw, and divide the bone; seize the fragment with the forceps and resect.

(*b*) The shaft of the fibula gives attachment to muscles by all its surfaces, and by its internal border to the interosseous membrane; expose the bone by a straight incision, pass the chain saw, and divide the shaft at proper points above and below the disease.

(*c*) The upper extremity of the fibula articulates with the external part of the head of the tibia; this articulation communicates with the knee-joint.

Fig. 222.



Resection of lower end of fibula.

Its ligaments are the anterior superior ligament, two or three flat bands, which pass obliquely upwards from the head of the fibula to the outer tuberosity of the tibia, and the posterior superior ligament, a single thick and broad band which passes from the back part of the head of the fibula to the back part of the outer tuberosity of the tibia.

The resection is effected by the straight incision; divide the bone with the chain-saw, raise the diseased part with the forceps, and effect the resection with the point of the knife.

(*d*) In resection of the entire fibula make an incision parallel with the bone its entire length, separate the soft parts with the periosteum, and divide the bone in the centre with the chain saw; now disarticulate each fragment separately.

The tibia is subjected to resection more frequently than any other long bone, owing to its subcutaneous situation. The results are most favorable, as new bone is readily reproduced when the periosteum is well preserved.[1]

The tibia is bound to the fibula by the following ligaments: The anterior, a flat band of fibres; the posterior, somewhat triangular; the transverse, long and narrow, and below the posterior. The internal lateral ligament unites the lower border of the internal malleolus to the astragalus, os calcis, and scaphoid.

(*a*) The lower extremity forms the upper and internal part of the ankle-joint; it is closely invested with tendons, and upon its postero-internal border the posterior tibial artery and nerve pass to the foot. Resection by the subperiosteal method of the entire diaphysis and lower epiphysis has resulted in reproduction of the bone removed and a useful limb.[2] Make a straight incision along the crest to the ankle-joint; saw the bone at the requisite height; raise the bone from its periosteal bed by carefully separating the periosteum; dislodge the tendons from their grooves, divide the ligamentous structures, and complete resection by detaching the bone from the articulation.

(*b*) The shaft of the tibia is subcutaneous on the anterior and inner part. On the posterior part it gives attachment to muscles, and along its external border is attached the interosseous ligament connecting it to the fibula. Resection of this portion is a comparatively simple operation. The operation will depend upon the extent of the disease, and the location of the sinuses if the disease is necrosis. The incision should be along the subcutaneous borders of the bone, and extend beyond the diseased portion; the periosteum should be thoroughly separated from the shaft, and the bone divided with a chain saw at either extremity; the fragment is then easily separated.

---

[1] L. Ollier.

[2] D. W. Cheevers.

Or, make a long curved incision in the length of the bone, having its convexity backwards; dissect this flap up and turn it outwards; divide the bone at the proper points, and raise the fragment with forceps. As excision of the shaft of the tibia is generally undertaken for necrosis, the gouge is found useful in separating dead bone, and the mallet may be used freely; it is also frequently desirable to use the trephine.

(*c*) The upper extremity of the tibia is broad, and presents upon its upper surface two cup-shaved cavities for articulation with the condyles of the femur.

The ligaments which are attached to it are, anteriorly, the ligamentum patellæ; internally, the internal lateral; posteriorly, the posterior ligament, or the ligamentum posticum Winslowii; and within, the anterior and posterior crucial ligaments.

The operative process is entirely subordinated to the degree, actual situation, and form of the disease; so that there may be occasion for the crucial, or the elliptical, or simple incision, and also for a variety of saws and bone-cutting instruments.[1] When practicable, subperiosteal resection should always be performed.

The knee-joint may be regarded as consisting of three articulations conjoined; namely, that between the patella and femur, and two others, one between each condyle of the femur and the tibia; the ligamentum mucosum is an indication of the original distinctness of the synovial membranes of the inner and outer joint; the crucial ligaments may be regarded as the external and internal lateral ligaments of those two joints respectively; each portion of the articular surface of the femur belongs either to one or other of the three component joints of the knee, and no part is common to any two of them.[2] The knee is a hinge-joint, having free motion in but two directions; it is supported principally by the lateral, the internal, and the posterior ligaments, and in front by the patella, and its ligamentous attachments; it has also a capsular ligament; the articular face of the tibia has a semilunar fibro-cartilage, which deepens the articular surface for the condyles of the femur.

The usefulness of the limb is thus recorded: In excisions for disease in 420 cases, 14.3 per cent. were perfect, 42.4 per cent. were useful, 4.6 per cent, not useful, and 17.8 were amputated; for injuries, in 17 cases, 17.6 per cent. were perfect, 64.7 per cent. were useful, and 11.7 per cent. were amputated; for shot injuries, in 17 cases, 58.8 per cent. were useful, and 23.5 per cent. amputated; in 46 cases of excision for deformity, 19.5 per cent. had perfect, and 67.8 per cent. had useful limbs; the amount of bone removed varied from half an inch to over four inches, but the usefulness did not depend upon the extent removed; the removal of the patella secures a greater degree of usefulness than its retention in the proportion of 76.9 per cent. of the former to 31.4 per cent. of the latter.

---

[1] R. Volkmann.

[2] Quain's Anatomy.

From these facts it would appear that this excision gives a large percentage of useful limbs. If it were true that the value of the limb depends upon a permanently firm, unyielding, osseous union of the femur and tibia, we might conclude that the recorded results should be taken with some allowance, for too often the union proves to be fibrous and has been followed by amputation,[1] or the limb bends under constant use, or bows outward or inward, or disease recurs.[2] But great progress has recently been made in perfecting excision at this joint, and limited motion is no longer regarded as impairing its function.[3] The results that have followed the efforts that have been made to preserve the natural relations of the fibrous structures and muscles,[4] give gratifying proofs that the knee-joint will be no exception to the rule that excision should, as far as practicable, restore the functions of joints.

Present experience indicates that excision should be had recourse to whenever the injury or disease is of a nature to destroy the function of the joint, and require anchylosis to render the limb useful. It is generally undertaken for chronic affections which cause ulcerative processes within the joint. The antiseptic method has relieved the operation of all of its former dangers. It is no longer a question of age, or sex, or even physical health, but the decision should rest entirely upon the determination of the nature of the disease, and its final results upon the usefulness of the limb.

The following suggestions as to the extent of the excision are important: The patella should not be removed, unless diseased, as it is essential to the formation of a firm, well applied flap;[1] if carious, the diseased part may be removed with the gouge or forceps; in excision of the knee-joint in children, remove at first a thin slice of bone, and, in case this should not suffice, with the gouge scrape out carefully the softened and broken-down osseous tissue, leaving the much thinned cortical substance with the periosteum, behind; the epiphyseal cartilage is often by this means laid entirely bare from the side of the joint; if perforated with fistulous openings a small spoon must be introduced and every particle of diseased tissue removed; in very young children it will often even not be necessary to remove any part of the tibia with the saw, it being practicable to remove the diseased part with the spoon; if the epiphyseal cartilage can be saved only in part, no more should be sacrificed than is actually necessary.[1]

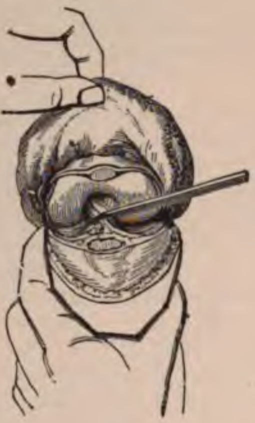
The method of operating will depend upon the kind of joint sought to be obtained; if union of the excised bones is necessary, the U-shaped incision is in general preferable to others, as it permits the removal of any necessary amount of bone without injuring the soft parts, and both corners of the wound are situated as low as the anatomical conditions will allow.[1] If an attempt is made to retain motion, a lateral incision[4] is to be preferred, which admits of exsection with the least destruction of the ligamentous tissues of the joint. In exsection designed to secure union, the articular surface should be so divided as to give a forward angle at the point of union; this is secured by sawing the bones in lines converging forwards; the amount of bone removed must, of course, depend upon the extent of the disease.

---

[1] R. Volkmann. [2] T. Holmes. [3] C. Hüter. [4] Von Langenbeck.

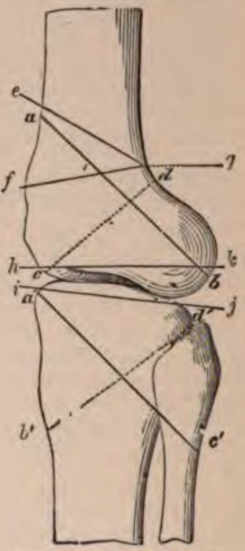
Exsect as follows:[1] The leg being slightly flexed on the thigh, make a curved incision, commencing at the insertion of the internal lateral ligament into the inner condyle of the femur, and passing just below the lower extremity of the patella, terminate it at the same point on the external aspect of the joint; the lateral incisions should not be made lower than the insertion of the lateral ligaments, to avoid division of the articular arteries, 1 (Fig. 225).; remove all diseased and degenerated tissues; reflect this flap upwards (Fig. 223); remove the patella, if diseased, if not, leave it undisturbed and divide the lateral and interarticular ligaments; pass a fold of cloth through the joint, and draw it firmly under the extremity of the bone to be sawn, thus completely isolating the soft parts behind; apply the saw first to the extremity of the femur, and then to the articular head of the tibia. The condyles have been made convex and the tibia concave, from before backwards, so that the condyles fit the head of the tibia, as in a ball-and-socket joint.[2] The bones must be maintained in apposition by two or three silver wires, which should now be introduced into the anterior part of the tibia and femur, and, when sufficiently twisted, cut off, and the ends turned down between the bones. Nails have been employed to fix the bones in position, which are removed at the end of two or three weeks.

Fig. 223.



Excision of knee.

Fig. 224.



Different lines of excision.

Subperiosteal resection, with lateral curved incision, is made as follows,[3] 2 (Fig. 225): Extend the knee and make a curved incision five to six inches

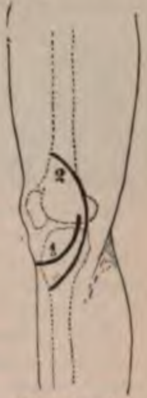
---

[1] J. R. Wood.

[2] G. E. Fenwick.

[3] Von Langenbeck.

Fig. 225.



Methods of excision.

long on the inner side, beginning two inches above the patella, at the inner border of the rectus femoris muscle, its convexity looking backwards, passing over the posterior edge of the internal condyle and ending on the inner side of the crest of the tibia, two or three inches below the patella. In the upper part of the wound is the vastus internus, beneath which the tendon of the adductor magnus presents itself; in the lower portion the tendon of the sartorius muscle is seen; these tendons must not be injured; cut through the internal lateral ligament in the line of the joint; separate the internal insertion of the capsule from the anterior surface of the internal condyle as high as the vastus internus; detach the internal alar ligament from the anterior border of the tibia to the middle line; flex the knee, and, as it is again slowly extended, by a powerful effort luxate the patella outwards; divide the crucial ligaments, and to separate the posterior crucial ligament from the spine of the tibia rotate the internal condyle of the tibia forwards; divide the external lateral ligament together with the adjoining portion of the capsule, by a free crescent-shaped incision, carried several lines below the tip of the external epicondyle; the joint now gaps widely; cut the posterior wall of the capsule; push the articular heads of the femur and tibia successively forward, and saw them off; if it is necessary to remove the patella, cut around it with the knife at the border of its cartilaginous surface, and then, by means of the periosteal knife, peel it out of its periosteum, so that the latter continues in connection with the ligamentum patellæ and the extensor tendons. Before the wound is closed, a strong drainage-tube is inserted, and allowed to protrude at the most depending part. It is sometimes useful to make a counter-opening out of which the other end of the drainage-tube is allowed to hang, as also one through the upper attachment of the capsule of the joint.

The dressings should be antiseptic, viz., layers of iodoform gauze next to the wound, then gauze bandages treated with bichloride solution, next borated cotton firmly bound by gauze bandages, and last gypsum bandages sufficient to immobilize the knee. The more superficial dressings should extend from the hip to the ankle. The limb should now be placed in a sling. The dressings should not be changed, except to remove the drain-tube, for several weeks. The wires are allowed to remain, but nails must be withdrawn after several weeks.

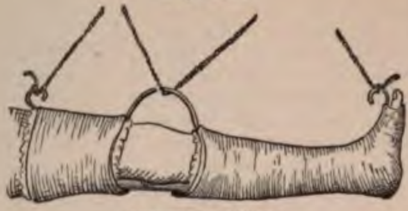
If, for any special conditions, it is important to expose the wound frequently the following apparatus is useful:[1] Provide a compress by folding a strip of firm cloth, or lint, extending from just below the tuber ischii nearly to the heel, twelve times together, and of such width as not to touch the angles of the incision; dip it in a solution of plaster-of-Paris, and apply it to the posterior surface; retain it by gypsum bandages, so applied as to leave the front part of the knee uncovered; an iron brace may be added over the knee for strength.[2] Or, make a wooden concave splint to the calf of the leg and back of thigh, but narrow at the knee; also an iron rod for suspension, apply the dressing thus: Pad the posterior splint with lint or cotton-wool, and cover that part corresponding to the site of the wound with gutta-

---

[1] P. H. Watson; F. Esmarch.

[2] A. Velpeau.

Fig. 226.



Suspension of leg.

percha cloth, or hot paraffine; place the limb in position and carefully adjust it; place the iron rod on the front and lay folded lint between it and the limb at the groin, at the upper part of the tibia, and at the bend of the ankle; apply an open woven roller bandage around the whole dressing from the toes upwards except at the site of the wound; over this apply the gypsum bandage in two or three layers; when the dressing is firm, suspend the limb by the hooks; the wounds may now be dressed without disturbing the part.

The patella, though in immediate relation with the knee-joint, may be excised with good results. Make a crucial incision, the transverse branch being over the base of the bone, or a second transverse incision may be made near the apex; dissect the flaps off cautiously, and remove the bone or its fragments; the tendinous expansion surrounding the bone should be separated, and not divided, as far as possible. The antiseptic method should be strictly pursued, and the iodoform dressings applied.

If the fragments of bone are not too much detached they may be united with catgut sutures, and union secured. It is often better to introduce the drains on either side of the joint through openings in the skin made at the most dependent part of the joint.

The femur is the largest bone of the skeleton. Resection of different portions of the bone are very frequent and give satisfactory results, especially when the periosteum is preserved, as new bone is reproduced.[1]

(*a*) The lower extremity is rarely removed, except in exsections of the knee-joints. When it is necessary to operate for necrosis in this region, the sinuses are the safest guides to the dead bone. If, however, a formal operation is required, make a long straight or slightly curved incision on the external aspect of the knee, isolate the femur a little above the condyles, preserving the periosteum, and make section of the bone by the chain saw; the fragment is then made to protrude at the wound, seized with forceps, and disarticulated.

(*b*) The shaft of the femur gives attachment to muscles throughout nearly its entire extent, and to reach it without injury to the soft parts, the muscular septa must be followed, either along the antero-external region of the limb, or as indicated by the seat of the disease; the curved incision and the semilunar flap raised up from without inwards, and from behind forwards, may sometimes be necessary to lay bare the bone to a sufficient extent. The limb must be well supported by the gypsum or other dressing during the after-treatment.

(*c*) The trochanter major gives attachment to the gluteus medius and minimus, and by its fossa to the external rotators. In resection make a free crucial incision through the skin and tendon of the gluteus maximus, and when the surface is sufficiently exposed, use the gouge to scoop away the affected parts; if the disease prove extensive, divide the attachments of the glutei to the upper and forepart of the process, and then remove the entire trochanter with saw and forceps.

---

[1] T. Holmes; J. Bell.

(*d*) The upper extremity of the femur enters so largely into the exsections of the hip-joint that the methods of removal are essentially the same.

The hip-joint is a large ball-and-socket joint, in which the globular head of the femur is received into the acetabulum or cotyloid cavity of the innominate bone; the articulating surface of the acetabulum is formed by a broad, ribbon-shaped cartilage occupying the upper and outer part, and folded round a depression which, extending from the notch, is hollowed out in the bottom of the cavity, and is occupied by delicate adipose tissue covered with synovial membrane; the articulating surface of the femur presents a little beneath its centre a pit in which the round ligament is attached; movement is allowed in every direction, extension being limited by the anterior fibres of the capsular ligament, and flexion by the contact of the neck of the femur with the acetabulum.[1]

The usefulness of the limb after excision for disease is equivalent to 93.8 per cent. of the recovered cases; complete excision gives a better result in recovered cases than partial, the former having 45.8 per cent. and the latter 35.8 per cent. perfect limbs, and the former having 48.6 per cent. and the latter 56.6 useful limbs; after excision for shot injuries 3.9 more or less useful limbs and 5 imperfectly useful limbs are recorded in 119 cases.[2]

The indications for exsection are as follows: In compound dislocations;[3] in shot injuries when the head is shattered by the ball, or the ball is impacted in the head;[4] in disease, when there is suppuration and disorganization of the textures of the joint. Superficial or limited acetabular disease does not interfere with the performance, and good results, of excision of the head of the femur. Even when the acetabulum is much involved, or pelvic suppuration exists, it is important to afford a free escape to the pus by the removal of the head, neck, and great trochanter of the femur if necessary.[3] Abscesses should be explored though there is little or no fever. In general, there can be no doubt that an operation is imperative under the following conditions:[5] (1) in chronic coxitis with formation of abscesses and fistulous openings, the suppuration being abundant, with fever at night, and progressive weakness; (2) when an acute suppurating coxitis, with high increase of temperature, supervenes upon a chronic one in which dry granulations without suppuration have filled the acetabulum; (3) when an iliac abscess which is forming shows that pus has perforated the acetabulum and entered the pelvic cavity; (4) when during suppuration, the head of the femur has separated and left the acetabulum.[4]

The period of operating should be primary in compound dislocations and shot fractures. In disease it has not yet been accurately decided what is the earliest stage of its course in which the operation is justifiable, but the evidence strongly corroborates the opinion that

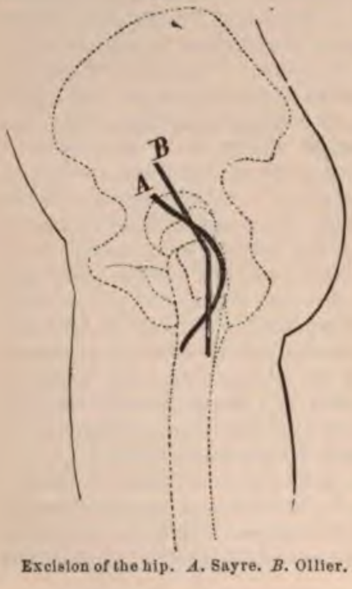
[1] Quain's Anatomy.
[2] H. Culbertson.
[3] F. H. Hamilton.
[4] R. Volkmann.
[5] T. Annandale.

usually it is delayed too long.[1] The surgeon cannot commit a greater error than by delaying excision too long in severe cases, and operating only when the patient is excessively debilitated.[2] Though the mortality would seem to diminish in proportion as the shaft is removed, yet there can be no doubt that, as a rule, the extent of the incision should depend upon the amount of disease; if limited to the head, that part alone should be removed;[3] if the neck is carious, the trochanter may still be preserved; but if the latter is involved, the bone must be divided at the trochanter minor.

The methods of operating are numerous, but the single incision along the axis of the trochanter, with subperiosteal removal of the bone most nearly meets the anatomical indication of the part. Of the several arteries distributed to this region, namely, the gluteal, sciatic, obturator, external and internal circumflex, and the superior perforating by anastomosis, the only one which approaches the line of this incision near enough to be incised before dividing into branches of distribution too small to give rise to noticeable hemorrhage, is a twig of the internal circumflex, which at one-eighth to one-fourth of an inch from the insertion of the obturator externus breaks up into its terminal divisions; this branch may be avoided by keeping the point of the knife well against the bone, and dividing the tendon of the obturator externus muscle in the digital fossa.[4]

Excision is as follows:[5] The patient lying on the sound side, with a strong knife commence an incision, *A* (Fig. 227), at a point midway between the anterior inferior spinous process of the ilium and the top of the great trochanter; carry it in a curved line over the ilium in contact with the bone, across to the top of the great trochanter; extend it not directly over the centre of the trochanter, but midway between the centre and its posterior border; complete it by carrying the knife forward and inward, making the whole length of the incision four to six or eight inches, according to the size of the thigh; if the periosteum has not been divided by the first incision, carry the point of the knife along the same line a second or third time; an assistant separating the wound with the fingers or retractors, the great trochanter, *b* (Fig. 228), is exposed; with a narrow thick knife make an incision through the periosteum only at right angles with the first at a point an inch or an inch and a half below the top of the great trochanter, opposite or a little above the lesser trochanter, and

Fig. 227.



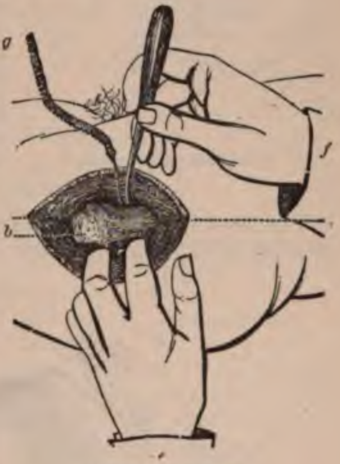
Excision of the hip. *A.* Sayre. *B.* Ollier.

---

[1] T. Annandale.
[2] R. Volkmann.
[3] Von Langenbeck; Schedè; C. Hüter.
[4] J. A. Wyeth.
[5] L. A. Sayre.

extend it as far as possible around the bone, making sure that the periosteum is freely divided; at the junction of the two incisions of the periosteum introduce the blade of the periosteal elevator, and gradually peel up the periosteum from either side with its fibrous attachments until the digital fossa has been reached; with the point of the knife applied to the bone divide the attachments of the rotator muscle, and continue to elevate the periosteum, carefully avoiding rupturing it at any point; when the periosteum is removed as far as necessary, adduct the limb slightly, depress the lower end of the femur sufficient to allow the head of the bone to be lifted out only so far as is requisite to permit its removal with the saw *g*; divide the bone just above the trochanter minor, and remove the fragment; if the head of the bone cannot be raised before division on account of the involucrum, saw the bone first and then remove the head; if the shaft at the point of section is necrosed, expose and exsect more; examine the acetabulum and if found diseased remove all dead bone; if perforated the internal periosteum will be found peeled off, making a kind of cavity behind the acetabulum, and all diseased bone must be very carefully chipped off down to the point where the periosteum is reflected from sound bone. Every part of the wound and all sinuses must be thoroughly cleaned of particles of bone and false membrane. The bichloride irrigation must be constantly employed until the wound is closed and the external dressings are about to be applied.

Fig. 228.



Passing chain saw.

Or, make an incision B (Fig. 227)[1] commencing about three inches below the crest of the ilium, and the same distance posterior to the anterior superior spine, downwards to the trochanter major, and then along the centre of the shaft of the bone.

An exploratory incision may be made by entering the knife immediately above and in a line with the posterior margin of the great trochanter, and making an incision sufficiently long and deep to allow the finger to explore the joint; extension of this incision upward or downward two inches will admit of excision of the head of the femur.

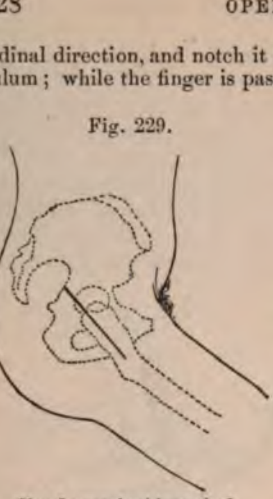
Or adopt the following method (Fig. 229):[2] Make a longitudinal incision over the great trochanter two and a half to four inches in length, in a line with the axis of the femur, and directed to the posterior superior spine of the iliac bone; two-thirds of the incision is made in the glutei muscles above the trochanter, and one-third on the trochanter; separate the muscles down to the neck of the femur, in the direction of the longitudinal incision until the neck of the femur and the margin of the acetabulum are entirely free; incise the capsule in a longitudinal direction, and notch it slightly on both sides at the margins of the acetabulum; while the finger is passed into the wound, cause rotation of the femur, which enables the operator to separate all the muscular attachments on either side of the incision; the head may be dislocated and sawn off, or the bone may be divided in place and the fragment removed.

---

[1] L. Ollier.

[2] Von Langenbeck.

Fig. 229.

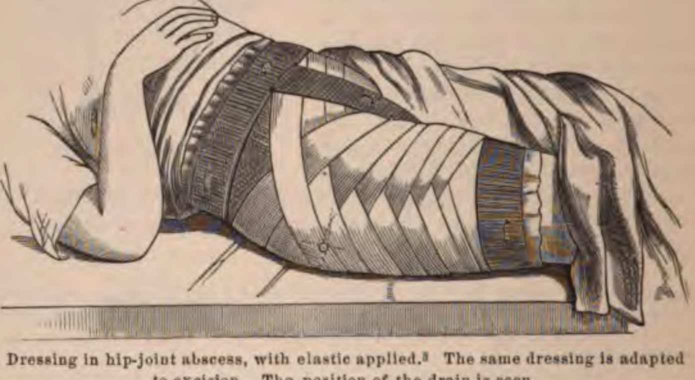


Von Langenbeck's method.

The operation[1] by a horizontal incision at the front part of the joint has been advised; the incision commences external to the crural nerve, and involves the sartorius, rectus, and tensor vaginæ femoris muscles. It is not well adapted for true excision of the joint, as it admits only of an operation on the neck of the femur, unless the incision is very large; as the wound is in front of the joint it does not favor entirely free drainage; the incision is, however, well adapted for simply dilating fistulæ situated in front of the joint, or for gouging out the joint by means of sharp spoons, or for the extraction of the head of the femur when separated.[2]

The dressings of the wound are simple. The irrigation with bichloride solution having been continued, introduce the drainage-tube to the bottom, then pack the wound with iodoform gauze; or, close the wound with sutures, to the tube, and apply iodoform gauze pads. Envelop all with a wide and thick layer of borated cotton, and apply the gauze bandage firmly. Place the patient on a smooth mattress, and make extension at the foot with a six pound weight. The upright position of the foot should be maintained, and the dressing should be changed as seldom as possible. When completed the dressings should envelop the upper part of the thigh, the hip, and pelvis (Fig. 230).[4] The patient should not attempt to walk with crutches until

Fig. 230.



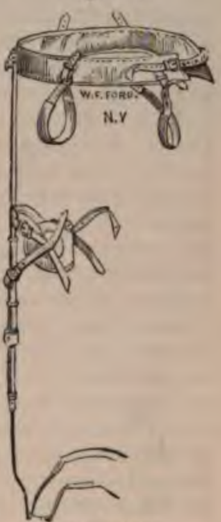
Dressing in hip-joint abscess, with elastic applied.[3] The same dressing is adapted to excision. The position of the drain is seen.

---

[1] Rozer. [2] R. Volkmann. [3] J. Lister. [4] W. W. Cheyne.

the external wound is quite healed, which ordinarily occurs with antiseptic treatment in five or six weeks. Attempts to bear weight on the foot should not be encouraged in six months, in order to allow of the fibrous structures to consolidate. During the period between the healing and using the limb the hip splint (Fig. 231) should be worn.

Fig. 231.



Hip splint.

With children, extension by the application, of weights and proper positions of the limb are the best means; the patient may be placed on a divided mattress, of which two different parts, exactly corresponding to the spot where the excision was made, are separated by an interstice of several inches.[1]

BONES OF THE TRUNK.

The bones of the trunk form the walls of cavities containing vital organs, and give support to the limbs; resections are, therefore, generally partial, and must be performed with such care and by such methods as will not impair those functions.

The vertebræ have been subjected to frequent partial resections. The removal of loose fragments after severe injuries, as from shot, are perfectly rational, and have resulted in a fair measure of success.[2] Resections of the arches or trephining the spine is one of the most difficult[3] and fatal operations in surgery, and practically without benefit. Eighty per cent. of terminated cases have proved fatal, and there is no well-authenticated case of complete recovery.[4] The conclusion is inevitable that until new and more favorable conditions are established, resection of the arch cannot be accepted as a justifiable operation.

If resection is attempted, proceed with the operation, as follows:[5] Make a long incision above the ridge of the spinous processes, the middle of which is opposite the displacement; divide all the attachments of the muscles to the articular processes; as one end of each muscular bundle is separated from its attachment, it retracts and needs little holding back; the saw or the nippers are generally sufficient to divide the vertebral arch; in sawing or cutting out the arch, grasp the spinous process, if it be not broken, with a pair of stout tooth forceps, which are to be preferred to the elevator for lifting the detached bone from its natural connections; a small crowned trephine may be used to cut through the vertebral arch or Hey's saw.

The sacrum may be partially resected for the relief of pressure upon nerves as follows: Make a crucial incision; remove the spinous process of the bone with forceps and Hey's saw; apply a trephine, and make an opening, through which introduce bone nippers, and remove the bone.

---

[1] R. Volkmann.

[2] G. A. Otis.

[3] P. F. Eve.

[4] J. Ashhurst, Jr.

[5] G. C. Blackman.

The coccyx may be excised in whole or part for necrosis, fracture, and a painful affection, coccydinia, thus: place the patient on the side, the thighs flexed, and the hips close to the edge of the bed; the buttocks being separated, make an incision in the median line, extending from the extremity of the coccyx upwards to the requisite extent; remove the diseased bone either with the gouge or the drill, or the bone may be divided with the cutting forceps. The forefinger in the rectum determines the progress and extent of the resection.

The ribs are closely invested on their internal surface by the pleura, and along the groove on the lower border runs the intercostal artery. The only admissible primary interference when the ribs are fractured by balls is the extraction of loose fragments, and the smoothing off of sharp-pointed ends.[1] Resection for necrosis should be made by opening existing sinuses and carefully separating the thickened periosteum with the pleura. In the removal of morbid growths, portions of ribs may require resection; great care must be taken to separate the pleura with the periosteum without wounding the former. Proceed as follows: Place the patient upon the sound side, and expose the bone by an incision along the middle of the rib, or the incision may be curved downwards: divide the intercostal muscles and disengage the intercostal artery from its groove in the inferior border of the bone; separate the pleura cautiously with the handle of the scalpel, or similar instrument, and pass a thin piece of pasteboard or other substance behind; divide the bone with the chain saw. Section of the posterior part of the rib may be first made to avoid wounding the pleura; scrape carefully each border of the bone, and do not incline the point of the knife towards the intercostal space. In removing the false ribs, support the free extremity while the rib is divided posteriorly.

The sternum has been frequently partially resected for shot injuries, and with very favorable results, the mortality being very slight.[2] When subperiosteal resection has been made for necrosis, new bone has been reproduced.[3] The incision for resection may be crucial or vertical, according to extent of injury or disease, and the parts may be removed by the trephine, gouge, or forceps.

BONES OF THE FACE.

In resection operations on the bones of the face it is important to avoid, as far as possible, incisions which will leave unsightly scars, and the removal of bones which destroy the symmetry of the features. When practicable, perform intra-buccal resections without external incision;[4] make incisions along the natural folds of skin and preserve borders of the mouth from division;[5] in all cases that admit of subperiosteal resection, this method is to be preferred.

The inferior maxilla is very liable to injury and necrosis, and to be the seat of morbid growths. In comminuted fractures the fragments should be preserved unless quite detached, as they have great vitality, and are important in the preservation of the contour of the

[1] G. A. Otis.
[2] O. Heyfelder.
[3] L. Ollier.
[4] J. R. Wood.
[5] Sir W. Fergusson.

jaw. For necrosis the resection should as far as possible be subperiosteal and intra-buccal, and both objects may often be accomplished by occasionally aiding the slow process of separation of the necrotic bone from its attachments to bone and periosteum with the elevator, or the handle of the scalpel, or a spatula.[1] By degrees the sequestrum is loosened, new bone forms around it from the periosteum, and eventually the dead bone may be lifted from its bed with perhaps slight incisions of the gum; by this method large portions of the jaw, and even the entire jaw, may be reproduced during the process of sequestration, and not only its contour but its function be preserved.[1] This method is preferable to early resection, which is liable to be followed by great contraction of the parts, even if the periosteum is preserved and new bone is produced.[2] In resection for tumors ample external incisions are often required, and large portions of the bone must be sacrificed. But small tumors, involving only the alveolus, may be removed with bone forceps without incision of the skin.[2] A considerable portion of the central part of the jaw may be removed without incising the lip, if the mucous membrane is freely divided between it and the bone, and the lip is drawn well down.[3] The wound must be disinfected with weak bichloride solutions 1–5000, care being taken to prevent its entering the stomach. In closing these wounds, endeavor to unite first the cut surfaces of the mucous membrane by sutures so applied as to cause slight eversion of the free margins into the mouth. Then accurately close the external wound using catgut drains, and apply iodoform dressings.

(*a*) When the entire central part is to be resected proceed as follows: Pass a stout ligature through the tip of the tongue to hold it in position when the muscles are incised; an assistant standing behind the patient holds his head firmly, and compresses the two facial arteries at the points where they cross the lower jaw; standing in front, seize with the left hand one of the angles of the lower lip, while an assistant holds the other angle from the bone, and the whole in a state of tension; divide the lip with a vertical incision through the median line down to the os hyoides, thus making flaps; or make a single curved incision along the lower margin of the jaw; raise the periosteum from the bone to be removed; extract a tooth opposite to each point where bone is to be sawn through; use a small Hey's saw, or the chain saw; the bone being sawn through on both sides, divide the muscles attached to it as closely as possible to their insertion, carrying the knife along the concave surface. Unite the two flaps with silver wire sutures passed through to the mucous membrane adjusting the margins of the lip; or use the hare-lip pins with figure-of-eight suture, if there is much tension; attach the ligature holding the tongue to a fold of adhesive strip firmly fastened.

Or, begin the incision at the angle of the mouth opposite the healthy portion of jaw; extend it down to the place at which the saw is to be applied; then along the base of the jaw past the middle line to the other point of section.[4]

---

[1] J. R. Wood.

[2] C. Heath.

[3] Von Langenbeck; M. Rizzoli.

[4] J. Bell.

(*b*) The horizontal portion has the following anatomical parts to be considered :—

Attached on its internal surface is the mylo-hyoideus muscle, beneath which is the fossa for the submaxillary gland ; on its external surface along its lower margin is the attachment of the platysma myoides muscle, and along its alveolar margin the buccinator ; the facial artery mounts over its lower border, just anterior to the insertion of the masseter muscle.

Resect as follows :[1] Make an incision commencing behind and a little above the angle, avoiding the facial nerve and parotid duct along the border of the jaw, terminating from a quarter to half an inch below the symphysis menti ; raise and reflect the flap on the face, tying both ends of the divided facial artery ; the bone being denuded, or the periosteum raised, divide with a chain-saw passed at the proper point anteriorly, a tooth being removed if necessary ; seize the end of the fragment with strong forceps, and divide with the chain-saw at or near the angle, as may be required ; close the wound firmly, care being taken to compress the surfaces of the incised mucous membrane closely to secure prompt union.

(*c*) The half of the lower jaw has the following additional relations :—

The rami terminate in two processes, one for articulation, and the other to give attachment to the temporal muscles ; the articulation is supported by an external and internal lateral ligament, and the capsular ; the stylo-maxillary passes from the styloid process to the angle of the jaw ; the internal maxillary artery passes behind the neck of the condyle in such proximity as to render care necessary to avoid wounding it in disarticulation of the jaw.

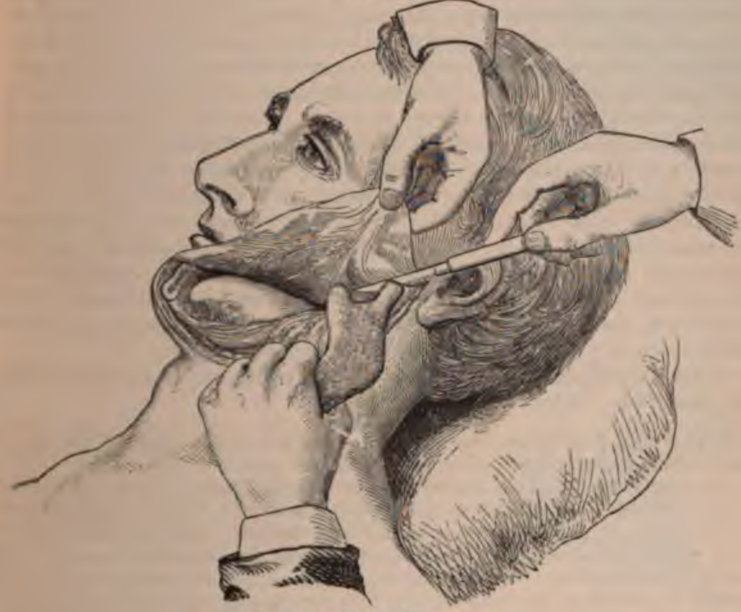
Resect as follows (Fig. 232) : Place the patient with the shoulders raised and head turned to the opposite side ; commence the incision at the zygomatic arch behind the condyle, carry it downwards behind the ramus to the angle, and under the body of the bone to a point one quarter of an inch below the symphysis menti if the operation is for an old necrosis,[1] but through the centre of the lip (Fig. 232), if for the removal of bone for other affections ; in the former case incise the periosteum and raise it from the bone throughout, but otherwise for the removal of a tumor ;[2] the facial artery must be cautiously divided and secured. Subperiosteal resection may now be rapidly performed for necrosis, the bone being divided with the chain or small straight back saw, and the cut end used as a lever to raise it from its position during the process of enucleation. If the periosteum is not saved, having divided the bone seize the cut extremity with the hand, raise it from its bed, carefully separating all tissues adherent to the body and ramus ; carry a narrow-bladed knife or curved scissors beneath the zygomatic arch, and behind the coronoid process, and with it divide the tendon of the temporal muscle while depressing the bone to disengage the process and luxate the condyle ; pull the bone strongly outwards, as far as possible from the vessels, in order to avoid especially the internal maxillary artery, and complete the operation by dividing the pterygoid muscles and the articular ligaments.

[1] J. R. Wood.

[2] C. Heath.

Secure every bleeding vessel, and close the wound by carefully adjusting the margins of the integument and of the mucous membrane.

Fig. 232.



Excision of half of lower jaw.

When the tumor is large and completely wedged in the upper part of the bone so as to hinder the freeing of the coronoid process, and prevent dislocation, cut off the tumor as high as possible with the bone-forceps or saw, and then remove the remaining portion of the jaw only in case the disease is malignant.[1]

(*d*) The entire lower jaw is removed as follows: Pass a ligature through the anterior part of the tongue, and trust to an assistant; make an incision commencing opposite the left condyle downwards towards the angle of the jaw, ranging at about two lines in front of the posterior border of the ramus, thence along the base, to terminate at the median line a little posterior to the most prominent part of the border of the jaw. Dissect[2] upwards the tissues of the cheek, and reflect downwards, for a short distance, the lower edge of the incision; separate the tissues forming the floor of the mouth, situated upon the inner surface of the body of the bone, from their attachments from a point near the median line, as far back as the angle of the jaw; next divide the attachments of the buccinator; secure by ligature the facial artery, the submental and the sublingual; expose the external surface of one branch of the jaw, and of the temporo-maxillary articulation, by dissecting the masseter upwards as far as the zygomatic arch;

---

[1] C. Heath.

[2] J. M. Carnochan.

seize the ramus and pull the coronoid process downwards below the zygoma; divide the insertion of the pterygoideus internus, grazing the bone in doing so; carefully avoid the lingual nerve, here in close proximity; divide the dental artery and nerve; separate the tissues attached to the inner face of the bone, as high up as a point situated about a line below the sigmoid notch, between the condyle and the coronoid process; detach the tendon of the temporal muscle by means of blunt curved scissors, or a probe-pointed bistoury, keeping close to the bone; make use of the ramus, now movable, as a lever to aid in the disarticulation of the bone; to effect safely the disarticulation of the condyle, penetrate the joint by cutting the ligaments before backwards and from without inwards; the articulation thus opens sufficiently to allow the condyle to be completely luxated; blunt scissors may now be used to cut carefully the internal part of the capsule, and the maxillary insertion of the external pterygoid muscle; by a slow movement of rotation of the ramus upon its axis the condyle is detached and the operation completed. To effect the removal of the other half, make the same incision on the opposite side, so as to meet the first on the median line; the dissection is similar.

The superior maxilla has the following important anatomical features:[1]—

It is attached to other bones in but three principal points: First, by its ascending process and articulations with the os unguis and ethmoid; second, by the orbital border of the malar, as far as the spheno-maxillary fissure; third, by the articulation of the two maxillary bones with each other and palate bone; there is a fourth point of contact behind with the pterygoid process and palate bone which yields easily by simple depression of the maxillary bone into the interior of the mouth; in attacking these different points no large vessel is injured; the trunk of the internal maxillary artery may be easily avoided, or in any case tied after the removal of the bone; moreover, in case of unforeseen hemorrhage during the operation we have a resource in compression of the carotid; only one important nerve trunk, the superior maxillary, need be divided.

Fig. 233.

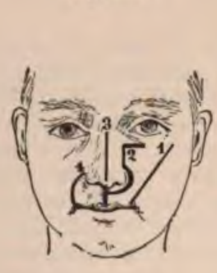
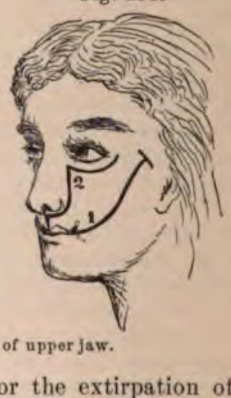


Fig. 234.



Lines of incision for resection of upper jaw.

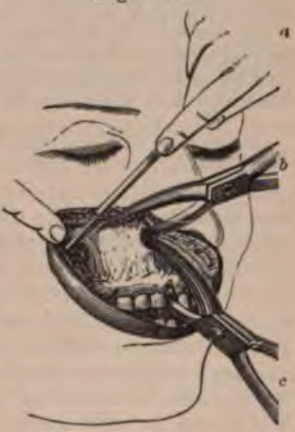
Resection of the bone is performed for the extirpation of malignant growths and to gain access to naso-pharyngeal tumors; in the former case it is justifiable, only where the disease is limited to the upper jaw and its corresponding palate bone, owing to the certainty of recurrence if the disease extends beyond.[1] The methods of procedure are numerous, and give great and desirable latitude[2] to the operator. Early operators cut boldly through the cheek,[3] 1 (Fig. 234), but, to avoid unsightly scars, the rule now obtains of making the incision in the course of natural folds of the skin, 2 (Fig. 234),[2] and 2[4] and 4[5] (Fig. 233). Subperiosteal resection may be made by these incisions, but a more formal operation is made by following the line 1 (Fig. 233).[6]

---

[1] J. F. Malgaigne.

Resect the superior maxilla below the floor of the orbit[5] (Fig. 234), by the following operation: Make an incision slightly convex backwards commencing at the ala of the nose, and terminating at the corresponding commissure of the lip, following the naso-labial fold or furrow, 4 (Fig. 233); dissect up the two flaps resulting from this incision until the nostril is exposed, and the malar process is completely denuded; with a small saw held in the right hand, *a*, saw through the malar process from above downwards, and a little from within outwards; the soft palate having been detached from the posterior border of the palatine bone by a transverse incision made at the posterior border of the last great molar, and an incisor tooth having been extracted, divide the horizontal portion of the maxilla from before backwards with cutting forceps, *c*, one branch being in the mouth, and the other in the nares; make a section of the bone from the divided malar process to the nares by the forceps *b*; seize the bone with strong forceps, and remove, fracturing the pterygoid process. After thorough disinfection of the wound, apply iodoform dressings.

Fig. 235.



Resection of upper jaw.

The entire maxilla or portions may be resected as follows:[2] Extract the incisor teeth of that side; divide the upper lip in the median line to the nostril; continue the incision around the ala and up the side of the nose, towards the inner canthus of the eye, thence continue it in a slight curve below the orbit, 2 (Fig. 233[2]), or, to the malar bone, 2 (Fig. 234); reflect the skin from the bone, and with a narrow saw passed into the nostril divide the alveolus and hard palate; incise the mucous membrane of the mouth as far back as the soft palate; with a narrow saw passed into the nostril divide the alveolus and hard palate; cut partially also the malar process of the maxillary bone, or, if necessary, the bone itself, and the nasal process of the superior maxilla, and complete the division of these bones with the forceps;

---

[1] J. Bell.
[2] Sir W. Fergusson.
[3] Lizars.
[4] E. Nélaton.
[5] A. Guerin.
[6] L. Ollier.

grasp the bone with the lion forceps, and detach it forcibly from the pterygoid process and palate bone; when the bone is loose, raise the fascia of the orbital palate, separate the infra-orbital nerve, the soft palate, and any adhering tissues. The hemorrhage must be suppressed by ligatures and the actual cautery, and the wound adjusted at the lips by hare-lip pins and in other parts by carbolized silk sutures.

If resection is necessary by an incision through the cheek:[1] Make an incision with the convexity downwards, 1 (Fig. 234), from the commissure of the lips to the temporal fossa; dissect this large flap from below upwards, and turn it back upon the forehead; cut through with the forceps the external orbital process at its juncture with the malar bone, the zygomatic arch, the os unguis, and the ascending nasal process of the upper jaw; divide the soft parts which connect the ala of the nose to the maxillary bone, and separate the maxillæ in front with a chisel and mallet, or a small saw; detach the soft parts from the floor of the orbit, divide at once the superior maxillary nerve, and the connections of the bone with the pterygoid process; conclude the operation by cutting through with the bistoury, or curved scissors, the velum of the palate, and the remaining soft parts which still adhere to and retain the bone. The chain saw may be used to divide the processes.

Resection without external incision may be made as follows:[2] The head being thrown back in position, and the mouth kept open by the gag placed between the back teeth of the opposite side, place a sponge cut so as to completely fill up the passage to the throat, and hold it in position on the soft palate by a sponge-holder to prevent the blood passing into the throat during the first part of the operation, the patient being allowed to breathe only through the nose; make two internal incisions from behind, half an inch on each side of the fangs of the molars forward to the central incisor of the opposite side; denude the periosteum with the elevator by commencing externally at the central incisor, and passing backward to the internal pterygoid process, and upward to the malar bone; then internally from the same point to and a little past the centre of the palate; the sponge now being of no further use, remove it; denude the tensor-palati muscle from its attachment to the posterior part of the hard palate; care being taken not to injure the posterior palatine vessels and descending palatine nerve that pass at this point forward on to the hard palate through the posterior foramen and along a groove; now extract the lateral incisor of that side, and by its socket, though a little to the right of the centre of the hard palate, make a section with a saw, so as to save the vomer, dividing the superior maxillary bones; change this saw for one much shorter, the teeth of which have a different angle, and the cheek falls into a U shank which allows the saw to play freely; make a section up between the tumor and the internal pterygoid process to the malar bone, then forward through the canine fossa, dividing also the inferior turbinated bone, to meet the other section at the ala nasi; after the saw has entered the antrum in this last section, the handle should be advanced more rapidly than the point; this prevents the point from piercing the vomer. By these two sections a tumor with adjacent bone may be removed clean.

---

[1] A. Velpeau, J. Syme, R. Liston.

[2] H. D. Goodwillie.

The superior maxillæ may be removed at a single operation by an incision, 3 (Fig. 233), along the centre of the nose and through the upper lip; additional incisions may be made, if required, under the orbit laterally. Or, a four-cornered flap may be made by an incision on either side from the angles of the mouth to the external angles of the eye, 1 (Fig. 233).

IV. OSTEOPLASTY.

The transplantation of bone consists in raising bone, covered with its periosteum, and placing it in a new position for the purpose of filling gaps created by disease or operations. The superior maxilla has been resected so far as to permit the removal of naso-pharyngeal polypi, and been replaced with perfect restoration of its integrity;[1] portions of the hard palate have been cut away and placed in apposition with similar sections from the opposite in staphyloraphy;[2] the chasm between the fragments of ununited bone has been successfully filled by dividing the long axis, and turning it down so that it filled the space. The requisite to success is the preservation of the fibrous and periosteal attachments of the fragment removed to the bone from which it is separated.

V. OSTEOTOMY.

This operation consists in the division of bone with a saw or chisel, and is chiefly employed to correct deformities.[1] Since the introduction of the antiseptic treatment of wounds this operation has assumed a position of the first importance, and ranks among the most useful and safest procedures in surgery. It is now possible to correct nearly every grade of deformity of the limbs, with the most absolute precision, without endangering life. The details of the operation will be reserved for the section on deformities.

VI. OSTEOCLASIS.

The fracture of bone has been practised for the purpose of correcting deformities. Instruments have been devised for the purpose of enabling the surgeon to fracture the bone at the exact point selected. It is an operation of very limited application, and has been quite superseded by osteotomy.

---

[1] Von Langenbeck.

[2] Sir W. Fergusson.

III.

THE MUSCULAR SYSTEM.

THE MUSCLES; THE TENDONS; THE FASCIÆ; THE BURSÆ.

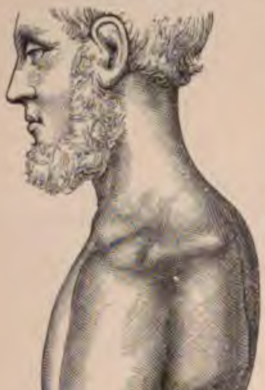
CHAPTER XXI.

INJURIES OF THE MUSCULAR SYSTEM, AND SPECIAL OPERATIONS.

I. MUSCLES AND TENDONS.

Ruptures of muscles and tendons may be partial or complete. The former are sprains, and occur in severe wrenches of the limbs or back; they are restored by rest and hot applications, and, when the soreness is relieved, by gentle movements, massage and galvanism. A muscle may be completely ruptured subcutaneously when the whole force is thrown in a violent and unexpected manner upon one or two muscles, or in violent paroxysms of muscular spasms, as in tetanus; the point of separation is commonly at the junction of the muscle with the tendon, or at the attachment to the bone. The accident is attended with extreme pain, resembling that occasioned by a smart blow from a stick, and often by a distinct sound like the snapping of a cord; all motion of the part is either impossible, or is accompanied by such severe pain, with spasmodic twitching, as to cause the patient to desist; deep indentations are found at the seat of rupture by retraction of the divided ends, and often considerable swellings; there is always extravasation of blood with discoloration of the skin. Simple subcutaneous ruptures are not serious injuries.[1]

Fig. 236.



Atrophy of capsular muscles of shoulders.[2]

When there is rupture of the muscles about the shoulder atrophy may rapidly follow (Fig. 236), owing probably to implication of the circumflex and supracapsular nerves, and consequent interference with nutrition of the part.[2]

---

[1] T. Billroth.

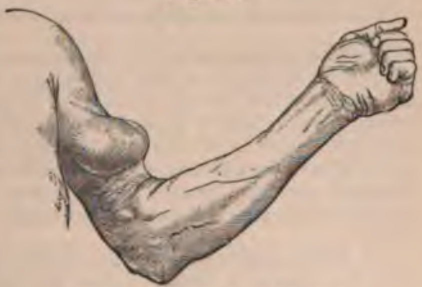
[2] J. E. Erichsen.

Place the part in a position most favorable for relaxing the muscles, and bringing the surfaces in apposition, and support it with splints and other appliances; maintain the extremities of the separated muscle in contact by evenly applied flannel bandages or laced belts, aided in some cases by a strip of leather or gutta percha. At first there is a connective tissue intermediate substance which soon undergoes such shortening and atrophy that a firm tendinous cicatrix forms. Functional disturbances rarely remain of any considerable amount, though there may be some weakness of the extremity and loss of delicate movement. If the rupture involve the skin also, the injury is grave in proportion to the extent of the laceration; if the muscle protrudes at the wound, it must not be cut away but reduced to position; if necessary, enlarge the wound of the skin, and after replacement close the wound with antiseptic dressing and treat it with a view to secure union without suppuration.

Displacement of muscles and tendons occurs where they are long and slender, as in the arm and back. It results from sudden and forced movements by which the muscle is compelled to act beyond its ordinary range of movements. The symptoms are severe pain at the seat of displacement and inability to make certain movements. The diagnosis depends upon determining the particular movement which cannot be made, the seat of pain, and if the tendon is elevated recognizing its location. The muscles of the back and neck, the long tendon of the biceps, the tendons at the wrist and that of the long peroneus are more often displaced. Reduction must be attended by: (1) relaxing the muscle as completely as possible by placing the part in the position of its full contraction; or (2) kneading the muscle with the thumb or rubbing it with the hand in the direction of reduction; or (3) make pressure over the part while the patient contracts the muscle; or (4) suddenly stretch the muscle by putting the part in position to effect this object.[1] If reduction is impossible, the muscle usually accommodates itself to the new position.

Hernia of muscle exists when its aponeurosis yields and allows the muscle to protrude through it (Fig. 237). It is recognized from other tumors by the fulness and hardness which occur when the muscle contracts. When the injury is recent, rest with uniform pressure may be sufficient. If this fail, and the limb is impaired, make an incision down to the rent, freshen the margins of the muscle and close it accurately with the continuous catgut suture.

Fig. 237.



Ruptured long tendon of biceps[2]

Hæmatoma, or a tumor of blood, often forms at the seat of rupture of a muscle. It will be soft, fluctuating, painless, and generally dark. It may disappear by absorption, or may suppurate. If it does not disappear, or suppurates, expose the cavity by incision, remove the contents, and with the curette thoroughly cleanse every recess of the abscess; irrigate freely with sublimate solution, and close the wound with deep sutures, leaving a drainage-tube in the deepest and most depending part for two or three days. Firm pressure should be made with compresses to place in apposition the deep sutures.

---

[1] G. W. Callender.

[2] T. Bryant.

Incised wounds of muscles and tendons are followed by retraction of the cut ends. There is always observed a peculiar inversion, subsidence, or tucking in of the muscular fibres at the divided parts, so that nearly all the fasciculi direct their cut ends towards the subjacent bone or fascia; in repair, new muscular fibres are never formed, but the retracted portions become inclosed in a tough, fibrous bond of union; in some cases the cut ends of the muscle are imperfectly united, but the action of the muscle is not lost, for one or both of its ends, acquiring new attachments to the subjacent parts, still act though with diminished range.[1] A divided tendon is recognized by loss of function, and the depression at the point of separation. This is one of the few structures of the body capable of complete reproduction, and the extent of the new part varies within given limits, according to the separation of the cut tendon.[2] The obstacles to perfect union of tendon are: failure to maintain the parts in apposition, too early use of the limb, division in dense fibrous sheaths, the extremities becoming adherent to the inner surface of the sheath. If the wound is open or subcutaneous, approximate the cut extremities of the muscle as perfectly as possible both by position and dressings, and retain them in this condition by absolute rest If the wound is open, employ deep sutures to muscles, and then to the skin, with bandages above and below fastened over the wound so as give uniform support and prevent separation. In a division of a tendon place and maintain the limb in such position as to secure easy apposition of the cut extremities; if the wound is open, first unite the cut extremities of the tendon by suture, as carbolized Chinese silk or worm gut, and then close the external wound; avoid putting the tendon on the stretch for several weeks. Irrigate the wound with bichloride solution during the operation.

The following muscles and tendons are more frequently ruptured:—

(*a*) **The triceps extensor cubiti** usually ruptures at the insertion into the olecranon; bandage the arm from above downwards, with a splint in front to keep it extended; or apply adhesive strips over the body of the muscles, and allowing them to cross over the olecranon, make firm traction and fasten the ends over the splint on the anterior surface.

(*b*) **The biceps flexor cubiti** is liable to have the tendon of its long head ruptured, the other usually ruptures at a later date;[3] bandage the arm upwards, and fix the limb with the hand upon the opposite shoulder; union rarely occurs.

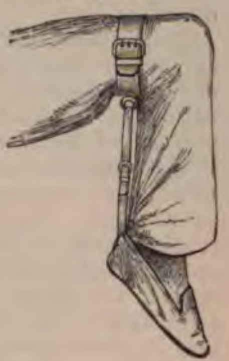
(*c*) **The quadriceps extensor cruris** may be ruptured near the patella; place the limb on a straight splint, the foot elevated; fix the patella with adhesive strips so that it cannot descend; apply adhesive strips over the entire compound muscle, each commencing at the upper limits of the thigh; but all converging to the patella; to the combined strips united, attach a rope passing over a pulley, and add a weight sufficient to maintain the parts in position.

---

[1] Sir J. Paget. [2] W. Adams. [3] T. Bryant.

(*d*) **The tendo Achillis** may rupture, or be detached from its insertion into the os calcis. Immediately apply a bandage to the leg from above downwards over the calf, but stop short of the point of separation, let the tendon be forced down to the bone and form attachments. Extend the foot on the leg, flex the leg on the thigh, and fix the parts in this position by attaching a belt placed above the knee to the heel of a stout slipper on the foot, if the tendon is detached from its insertion (Fig. 238).

Fig. 238.



Strap for rupture of the tendo Achillis.

II. BURSÆ.

Wounds of bursæ are liable to lead to inflammation and suppuration; and, secondarily, involve the neighboring joints. Cleanse and disinfect the wound, with bichloride, and endeavor to secure immediate union; if pus form open the abscess and apply iodoform dressings.

CHAPTER XXII.

DISEASES OF THE MUSCULAR SYSTEM AND SPECIAL OPERATIONS.

I. MUSCLES AND TENDONS.

Inflammation of muscles, myositis, is rarely an idiopathic disease; it may occur, however, in the tongue, psoas, pectoral, and gluteal muscles, and in those of the thigh and calf of the leg; the acute form usually terminates in abscess, although resolution has been observed.[1] After an injury, the symptoms usually appear several weeks later, and result from some lack of repair in the injured part, due to the want of the necessary rest which an injured muscle so much requires in the process of healing.[2] It begins with parenchymatous swelling of the muscular fibres, and passes rapidly into suppuration and abscess; the bellies of entire muscles, as the psoas, may be converted into pus; but more commonly the abscess is limited to a spot varying in size from a pea to a walnut, according to the cause in each particular case; the most trifling inflammation affecting the striped muscles of the trunk and limbs occasions the most violent disturbance of function; the muscle rests in a state of contraction, and any attempt to extend it is most strenuously opposed by the patient on account of the intense pain to which it gives rise.[3] In large abscesses which are compressed by strong fasciæ there is contraction of the muscles in the substance of which the abscess develops, as in psoitis; but in small and not very painful abscesses, and in traumatic inflammations of the muscles, there is usually no contraction.[1] Resolution of the inflammation should be attempted by rest and the application of ice-bags.

---

[1] T. Billroth. [2] T. Bryant. [3] E. Rindfleisch.

When pus forms, it should be evacuated with antiseptic irrigation and dressings.

Inflammation of tendons, and their sheaths, is liable to follow sprains, or other injuries. The sheaths may inflame, with exudation of fibrinous serum, which often induces temporary or permanent adhesions of the sheath to the tendon; or suppuration may occur with necrosis of the tendons; there is now fever beginning with a chill; if the inflammation and suppuration extend, the fever becomes continued and remittent in form; if intermittent chills occur there is great danger. Inflammation of the sheaths, arising from unknown causes, begins as an acute phlegmon, the cellular tissue participates, and the limb swells greatly. The symptoms at the first are pain on motion, and slight swelling; sometimes a friction sound is present, or grating in the sheath perceptible to the ear or hand. Resolution may occur without suppuration, the limb remaining stiff a long time, as the adhesions between the sheath and tendon do not break down until after months of use; if extensive suppuration follow, the tendons usually become necrosed and escape from the abscesses as white threads or shreds, followed by permanent stiffness of the fingers. The treatment of slight inflammation of the tendons, with crepitation, is rest on a splint and local application of tincture of iodine, or add a blister.[1] If the symptoms are more severe, elevate the limb and apply ice; if this is painful, use hot fomentations over a large surface; if the inflammation extend, with throbbing, and hardness, make a free incision along the centre of the sheath, to relieve the tensely strangulated tissues, even though no pus is present.[2] If pus is detected, open the part, cleanse with bichloride solution, apply drain, and use iodoform dressings. If the disease still progresses, and the patient sinks, amputation of limb may be necessary to save life.[1] In the more chronic states, all abscesses should be freely opened, cleansed of pus and granulations, packed with iodoform strips of gauze, and dressed with iodoform pads.

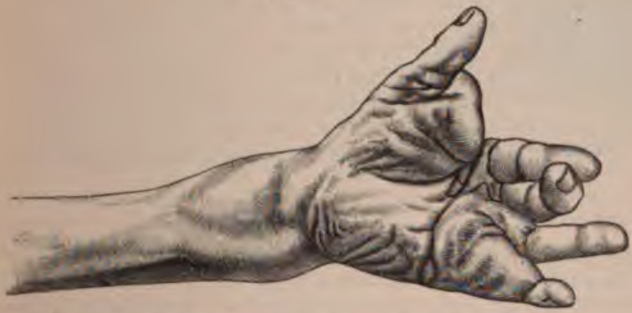
A ganglion is a swelling in the course of a tendon due to an accumulation of fluid within or connected with the sheath. The swelling may be diffused, simple, compound, or circumscribed. In the former the synovial sheaths, suffering chronic inflammation, become distended with a fluid, jelly-like, containing white bodies. The sheaths in the hand are most frequently affected; there is a gradual formation of a swelling in the hollow of the hand and the lower end of the volar side of the forearm, and the fluid may be felt passing in the sheath to the forearm under the ligament of the wrist; the fingers are generally flexed and cannot be fully extended; the movements of the hand and fingers are somewhat limited (Fig. 239), but there is no pain; the fluid is jelly-like, with white bodies. In the simple ganglion there is a partial hernia of the sheath, with dropsy, the ganglion forming a kind of sac-like protrusion about the size of a pigeon's egg, and filled with synovia; it appears most commonly on the dorsal surface of the wrist, in connection with the extensor tendons; it also contains thick mucus, and white bodies, like melon seeds.[1] In treatment avoid any operation which might cause suppuration. In dropsy of the sheath, open the sheath antiseptically, irrigate the entire cavity of the sheath with bichloride solution 1-2000, introduce a drain tube, close the wound, and apply iodoform dressings.

---

[1] T. Billroth.

[2] J. L. Clarke.

Fig. 239.



Ganglion involving all the flexor tendons of the hand and wrist.

If the antiseptic method cannot be applied, avoid operating as long as possible, and then proceed cautiously, as follows: Open the sheath either by incision or puncture, and inject iodine; if puncture is made, select a medium-sized trocar which will allow the escape of the fibrinous bodies; inject tepid water through the canula to force out these bodies; when all has been removed, inject slowly but forcibly a mixture of equal parts of tr. iodine and water, or add an equal quantity of iodide of potassium; remove the canula, cover the wound with a small compress, bind up the hand and forearm carefully and place it on a splint; if the tension subsequently becomes severe, remove the dressings, close the puncture with plaster and paint with iodine.[1]

Fig. 240.

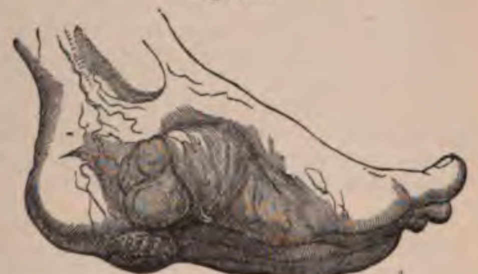


Fig. 241.

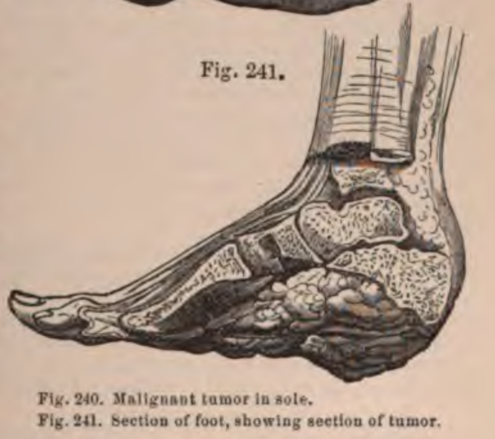


Fig. 240. Malignant tumor in sole.
Fig. 241. Section of foot, showing section of tumor.

In the case of simple ganglia, attempt rupture with the thumbs pressed firmly upon it or a blow with the back of a firmly bound book; failing, open it antiseptically, or by subcutaneous free incisions of the sac, and evacuate its contents into the connective tissue; irrigate with bichloride solution, drain, and dress

[1] T. Billroth.

with iodoform gauze, the limb should be kept at perfect rest during the treatment.

Tumors of muscle and tendon may occur of every variety, but the sarcomata are the most frequent and serious. They are not infrequently seen in the thigh and foot (Fig. 240). Sarcoma of the tendinous sheath appears in the sole as a soft fluctuating tumor, not unlike a ganglion for which it has been mistaken. It extends, and finally involves the neighboring tissues, forming a swelling of variable size, but readily diagnosticated as of a malignant character. Early extirpation is the rule of practice. If the growth is malignant the removal of tissue must be complete or amputation is preferable.

II. BURSÆ.

Bursæ are deep-seated or subcutaneous sacs to prevent friction; the former are interposed between a muscle or its tendon and a bone or the exterior of a joint, or between two muscles or tendons, and frequently communicate with the cavities of joints; the latter lie immediately under the skin, interposed between it and some firm prominence underneath.[1] From their location and function, they are peculiarly liable to injury, hence to inflammation.

Inflammation of the deep-seated bursæ appears as a local painful swelling, often mistaken for a common phlegmon. The inflammation may resolve with more or less consolidation, or terminate in suppuration, or assume a chronic form with an accumulation of fluid—dropsy. The early treatment should be rest and cold; if pus form the sac must be opened cautiously with antiseptics, and healed as quickly as possible; if it become dropsical, use blisters, tincture of iodine, and pressure, or open them for radical treatment by the antiseptic method. The bursæ, which occasionally enlarge, are numerous in the region of large joints, as the hip, the knee, the shoulder, and elbow; the following are examples:—

(*a*) **The deltoid bursa**[2] at times communicates with the joint through the bicipital groove; when inflamed there is swelling around the shoulder-joint, pain and crepitation on movement, simulating mischief in the joint; it may become distended with simple fluid, or loose bodies; the treatment should be absolute rest of the arm and blisters; it should be opened only after grave consideration, and when obstinate, and there is bulging in front of the deltoid. If antiseptics are used there is much less danger.

(*b*) **The quadriceps extensor cubiti bursa**[3] often inflames and the swelling is distinguished from that of the knee by being limited to the upper border of the patella, especially noticeable when the patient stands, and fluctuation is above and not through the joint. The treatment is rest, tr. iodine, blisters, and when very obstinate, tapping; if it suppurate it must be freely opened, but with antiseptics.

(*c*) **The ligamentum patella bursa**, distended by fluid, presents itself conspicuously on both sides of the ligamentum, extending from the tubercle to the top of the tibia; it is painful after exercise, swollen, and tender; the treatment is rest, blisters, and tr. iodine; as it often communicates with the joint, operations, as incision, puncture, the insertion of a seton, are very dangerous.

Other bursæ which are liable to inflame, and which must be treated on the same principles, are located as follows: Under the tendon of the subscapularis;

---

[1] Quain's Anatomy.

[2] T. Billroth.

[3] T. Bryant.

in the sheath of the long head of the biceps; between the tendon of the latissimus dorsi and the inferior angle of the scapula; under the insertions of the tendon of the biceps into the radius; under the tendon of the triceps; several at the hip, the largest beneath the conjoined tendon of the psoas and iliacus internus; several in the popliteal space; under the insertion of the tendo Achillis; about the ankle and tarsal articulations.

Of the superficial bursæ those on the patella and olecranon are types. If the inflammation is acute, the fluid collects rapidly, the skin is red, the swelling painful, preventing walking; the fluid may be wholly or partially absorbed, or the sac may suppurate, or rupture subcutaneously, or through the skin. The treatment of the acute stage is rest, with cold; and in the chronic stage rest, with tr. iodine, compression, blisters, mercurial ointment, or plasters. Compression,[1] by means of a well-padded splint in the ham, and a flannel roller bandage very firmly applied, often effects a prompt cure. But chronic dropsy of this, as of other bursæ, is not always curable by these remedies, and more radical measures are required; free incision, with bichloride solution, irrigation, drainage, and iodoform dressing, is preferable.

Injections are not dangerous if the patient remains quiet; use equal parts of strong tr. iodine and water; first draw off a portion of the fluid, then inject the preparation, retain it for several minutes, and withdraw whatever will re-enter the syringe.

If the sac is very thick, it is justifiable to extirpate it entirely, which must be done with great care to avoid injuring the capsule of the joint,[2] and the careful employment of bichloride solution irrigation. After the walls are reached, if the edge of the knife is directed towards the tumor, it may be dissected from the expanded tendon of the quadriceps, and from the patella, without injury to either; remove any redundancy of integument. Insert a drain; bring the edges of the flap exactly together; apply iodoform dressings and fix the limb in a fenestrated gypsum bandage.

III. CONTRACTION.

Although contraction can only take place in muscles, yet a wider meaning is generally given to the term, and tendons and fascia may become contracted, being shortened and shrunken, and without their normal elasticity.[3]

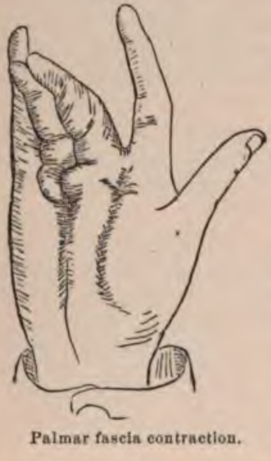
A muscle contracts when inflamed, and where there is inflammatory new formation in muscle, cicatricial connective tissue may take the place of the muscle; this process causes the drawing together by atrophy and induces contraction. Contractions may also result from continued direct irritation of certain nerves, or they may have a reflex origin, or follow as a result of long-continued paralysis of antagonizing muscles. Finally, shortening may occur as a result of continued approximation of the points of insertion, as in curvatures of the spine, and clubfoot; this form of contraction, contractured muscle,[3] is an adaptation of the muscle to the new relations of the points of origin and insertion, and is attended with diminished function, and consequently size, adaptive atrophy.[1] The treatment depends upon the cause; during inflammation extension should be maintained to avoid contraction, but if contraction finally occurs, deformity must be relieved by division of the muscles;[2] in paralysis of antagonizing muscles, as in infantile paralysis, contraction must be prevented by well-adjusted appliances; if contraction exist and has so long continued that the muscle has become adapted to its new position,[1] it must be divided before the deformity can be overcome.

---

[1] R. Volkmann. [2] T. Billroth. [3] A. Delpech.

A tendon undergoes contraction, both as a result of inflammation and from long-continued position, and not only causes deformities, but aggravates and renders permanent existing deformities. The treatment is the same as in contraction of muscles.

Fig. 242.



Palmar fascia contraction.

The fasciæ may shrink from the displacement of a part, by which the fascia is relaxed, as occurs in the fascia lata during hip-joint disease, or the contraction may occur as a result of a low grade of inflammation, especially in the palmar fascia. *The palmar fascia* contraction, though sometimes occurring in rheumatic persons, seems to be due to frequently repeated and protracted pressure of hard substances, as in in handling tools. The integument and subjacent fascia inflame, induration succeeds, and adhesion with contraction follows, with flexion of the finger to which the fascia is attached (Fig. 242), at first slight, but progressively increasing until in some cases the ends of the fingers are almost in contact with the palm of the hand. This morbid condition may occur in one or in both hands; the fingers are not usually all contracted to the same degree; the ring finger is generally more flexed than the others, and the little finger more than the index or middle finger. There is little or no pain, except an effort is made to extend the finger, when great resistance is offered and severe pain is induced; indurated and knotty cords can be seen and felt, extending from the palm to the fingers, the firmness of which is greatly increased by efforts at extension; these cords are formed by contracted bands of the palmar fascia together with the closely adherent integument; the skin of the palm is drawn into folds in the form of arcs of circles whose concavities are downwards towards the fingers; in some cases the sheath of the flexor tendon is involved in the vicinity of a single articulation, generally that of the first with the second phalanx. It is distinguished from paralysis of extensors by complete extension of fingers; from cicatrices by the absence of scar; from rheumatism by the healthy state of the joints; from contraction of flexor muscles and tendons by the absence of tension when there is extreme flexion of wrist. The case

[1] Sir J. Paget.

E. Brown-Séquard.

always progresses unfavorably when untreated, but recovery is effected if the contracted bands are thoroughly divided,[1] and the affected fingers are extended and maintained in that position by proper splints, and passive motion is vigorously and persistently applied. Secure full anæsthesia; make subcutaneous section as far as practicable at every point where there is tension; if the skin is very adherent, divide it, but as slightly as possible; close the wounds with adhesive plaster and place the fingers in an extended position; apply to the back of the forearm, hand, and affected fingers, a metallic splint adapted to the surface, with an intervening layer of lint or cotton-wool; secure the fingers to the corresponding portions of the splint by narrow strips of adhesive plaster, and the arm, by a bandage; renew the dressings at intervals of two or three days, and apply passive motion persistently until recovery is completed.

The fascia lata is liable to undergo permanent contraction by long continued spasmodic action of the tensor vaginæ femoris, as in hip-joint disease. Division of the muscle will not always be followed by sufficient relaxation of the fascia; wherever contractions still exist, section must be made with the long tenotome carried under the bands.

CHAPTER XXIII.

GENERAL OPERATIONS ON THE MUSCULAR SYSTEM.

I. MYOTOMY; TENOTOMY; FASCIATOMY.

These several general operations on the muscular system, namely, myotomy, section of muscle; tenotomy, section of tendon; and fasciatomy, section of fascia, are generally classed under the more common term, tenotomy. They are undertaken for the relief of deformities or displacement of parts, caused or maintained by the contraction of muscle, tendon, or fascia, or of all combined. The muscle and its tendon are more frequently alone at fault, but occasionally the fascia is also involved in the contraction. The true value of tenotomy does not consist simply in division of the contracted structures, but rather in substituting for the unyielding tissue a cicatrix capable of being extended, and which will enable the part to perform again its proper function. It follows that to render the operation successful, great discrimination is required in the selection of the muscle to be divided and the point of division, and in the after-treatment. In general the operator may select between division of the muscle and tendon, and then preference should always be given to the tendon, owing to the marked differences in the methods of repair of these two tissues, namely, in section of muscle repair is always by fibrous tissue, while tendon and fascia are regenerated. If the tendon has a synovial sheath avoid it if practicable,[2] or if divided, precautions should be

[1] A. C. Post; R. Abbe.

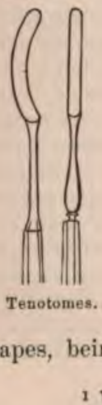
[2] T. Billroth.

taken to prevent inflammation by the use of a tenotome rendered aseptic by immersion in a carbolized solution.

The indications favorable to tenotomy depend upon the following conditions: (1) The contracted tissues must have undergone such adaptive changes as to render extension by mechanical means impossible or unadvisable; (2) the antagonizing muscles should not be so paralyzed that they are not capable of restoration of function, at least in some degree. To determine these questions the following general rules are useful, and should be fully applied in every case: (*a*) The force of the contraction may be tested as follows:[1] If the displaced limb can be brought nearly into position by the force of the hands, the contraction is not so great and permanent that mechanical appliances will not overcome the distortion; but if manual efforts do not greatly improve the abnormal position of the part, a condition exists which renders extension excessively tedious or quite impossible. (*b*) The permanency of the contraction is proved thus:[2] Place the part contracted as nearly as possible in its normal position by means of manual tension gradually applied, and then carefully retain it in that position; while the parts are thus placed upon the stretch, make additional point pressure with the end of the finger or thumb upon the parts thus rendered tense, and if such additional pressure produces reflex contractions, that tendon, fascia, or muscle must be divided, and the point at which the reflex spasm is excited is the point where the operation should be performed; but if the additional point pressure does not produce reflex contractions, the deformity can be permanently overcome by means of constant elastic extension. (*c*) The paralysis of antagonizing muscles is proved by their atrophy; the loss of voluntary power over them; their insensibility to the electric current; and finally, by the congenital, rather than non-congenital, nature of the distortion, the former being generally due to spasmodic contraction of the muscles involved, and the latter to paralysis of the antagonizing muscles.[1]

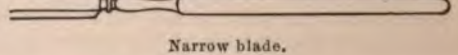
The instruments[2] (Fig. 243) are tenotomes of different construction. The handles should be so marked that the direction of the blade may be known when it is buried in the tissues; the shank should be one to one and three-fourths inches long; strong and firmly inserted into the handle; the blade should be three-quarters of an inch to one inch in length, very thick at the heel, very narrow in the cutting portion, and always blunt pointed, the point being somewhat rounded and sharpened from side to side, like a wedge or chisel, so that it will split rather than puncture the tissues; the blades are of various shapes, being straight or curved, having the cutting edge on the

Fig. 243.



Tenotomes.

Fig. 244.



Narrow blade.

---

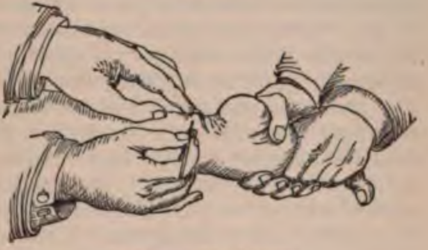
[1] W. Adams.

[2] L. A. Sayre.

convex or concave border; the steel should be properly tempered to prevent breaking in cutting condensed structures. For the division of fascia a longer blade is required, but a probe point is preferable to a sharp point (Fig. 244).

The operation is as follows:[1] Anæsthetics are necessary in severe operations; the tendon being made tense, introduce the antiseptic tenotome flatwise, with a rotatory motion, until the tendon, muscle, or fascia is reached (Fig. 245); carry the blade under the structure to its opposite side, then turn the cutting edge towards the tissue to be divided, the mark on the handle indicating the direction of the edge; press the tendon or muscle down upon the blade, at the same time giving the instrument a slightly sawing motion until the part gives way, which can be recognized by the finger, and often by a snap; the division being made complete, turn the instrument flatwise and withdraw it, the finger or thumb following and forcing out any blood in the track of the knife and preventing the entrance of air; the wound must be hermetically sealed by applying two strips of adhesive plaster which cross over the cut but do not surround the limb; secure them by a roller bandage.

Fig. 245.



Dividing tendo Achillis.

The treatment of the divided tissue should aim to secure reunion of the structure of such length and power as to maintain the proper balance of the forces acting on the part previously displaced. In order to effect this object the deformed part must be restored by such degrees as will not prevent the union of the several tissues; for if restoration is complete immediately after section, the smaller tendons may be so far separated that union will not take place, or the cut ends may unite to their sheaths. If the tendon is large, as the tendo Achillis, the deformed part may be at once restored,[2] but if the tendon is small, as the posterior tibial, extension should be gradual.[3] The object of gradual extension is not so much to elongate or stretch the new material, as to regulate its length, and the rate at which this is to be accomplished must depend upon the activity of the reparative process, and the required length of the new tendons.[3] The period must therefore vary from two weeks in a healthy child, to three or four weeks in the adult, and to five or six weeks in atrophied paralytic limbs.

TENOTOMY IN THE UPPER LIMBS.

The contractions of the muscular system which give rise to distortions of the upper limbs are very numerous, and tend to seriously impair function. Distortions of the fingers are peculiarly disabling, and require judicious treatment. Tenotomy, as a remedial measure, must be applied with great care, especially in the region of the hand, owing to the extended synovial sheaths.

---

[1] L. A. Sayre. [2] J. Syme; L. A. Sayre. [3] W. Adams.

The flexors profundus and sublimis digitorum are inserted into the phalanges by long tendons running in fibrous sheaths lined by synovial membrane. The deep flexors are inserted into the base of the third row of phalanges, and the superficial flexors into those of the second row; contraction of the long flexors consequently flexes the third phalanges, and contraction of the superficial flexors the second row. Section of these tendons is dangerous, owing to the liability to inflammation of the sheaths,[1] and should, therefore, be made with such precautions as will prevent the exposure of the synovial surface to injury or septic matter. The division should be made on the first or second phalanx. Enter the point of the knife, the blade having first been wet with carbolic solution, on the side of the second phalanx, near the anterior surface, and, having reached the tendon, cut to the bone; withdraw the knife, keeping the thumb of the left hand firmly applied to the wound which forces out any blood; the wound should instantly be hermetically sealed, and several days be allowed to elapse before the finger is fully extended. Section of the tendons in the palm is still more dangerous, owing to the proximity of arteries and nerves, as well as the large synovial sheaths. If the attempt is made to operate in the palm, make the tendon tense, and puncture anterior to the transverse fold of the skin to avoid the arterial arches, on a line with the middle of the metacarpal bones, and cut directly upon the bone; close the wound as in the former case.

The extensor communis digitorum is inserted into the base of the third row of phalanges; it has no important surgical relations at points where it is most accessible, namely, the dorsum of the metacarpus. Pinch up the skin over the tendon, and, avoiding the veins and articulations, pass the tenotome down to the tendon, and cut towards the bone; if several tendons are retracted, it is better to divide each separately, rather than by a single puncture, as is sometimes advised.

The extensor primi and secundi internodii and ossis metacarpi pollicis may fix the thumb in a state of extension; the radial artery passes beneath them where they cross the carpus. Section may be made by bringing the tendons out prominently; flex the extended thumb and abduct, which will make the extensors ossis metacarpi and secundi internodii pollicis prominent below the styloid process of the radius, at a point where the radial artery passes to the dorsum; if the blunt tenotome is inserted through an incision while the tendons are made tense, and kept well applied to it, division may be made without danger. The extensor primi internodii pollicis, lying more external, is now prominent, and may be divided safely where the artery passes under it, over the second phalanx.

The flexor carpi radialis runs along the radial side, and is inserted into the base of the second metacarpal, and has the radial vessels on its radial border. It may be divided above the wrist, the tenotome entering on the radial border of the tendon, made tense, but inside of the radial artery, and passed beneath it; or, if necessary, the palmaris longus may be divided at the same time; first cut the palmaris longus, and then the flexor carpi radialis.

---

[1] T. Billroth.

The flexor carpi ulnaris runs along the ulnar border, and is inserted into the pisiform bone, and has the ulnar vessels on its radial border. It can be safely divided by making it tense, and puncturing on the radial side, and keeping the blunt tenotome closely applied to the tendon.

The palmaris longus runs down the middle of the wrist, is inserted into the annular ligament and palmar fascia, and has the median nerve on its ulnar and posterior surface. Section is secured while the tendon is made prominent by passing the tenotome on its ulnar side carefully under it above the wrist or near its insertion, avoiding the median nerve, and cutting towards the skin.

The biceps flexor cubiti is inserted into the tubercle of the radius; it lies in front of the brachial artery and median nerve; it firmly flexes the forearm when permanently contracted; there is a marked prominence of the body of the muscle, and an elevated cord or band at the bend of the elbow when attempts are made to straighten the limb. Section is to be made above the aponeurotic expansion of the tendon, the contraction of which must be relieved, and from before backwards. Make firm extension of the forearm, and when the tendon is rigid, insert the tenotome at the external border, avoiding the median veins; depress the handle as the blade glides under the skin to the opposite border, turn the edge to the tendon and with a sawing motion divide it; the brachial artery is half an inch behind the tendon, and is not in danger unless the incision is made too freely.

The triceps extensor cubiti is inserted into the olecranon and has no other important feature than its relation to the joint on its under surface. Extension of the forearm is caused by contraction of the triceps; it may also prevent reduction of a backward dislocation. Section should be made by puncture, at least an inch above the joint, and on the inner border, to avoid the ulnar nerve; flexion should not be made for several days, and then gradually.

The pectoralis major is inserted into the anterior bicipital ridge of the humerus, and tends by its contraction to fix the arm on the front of the chest; it forms the anterior wall of the axillary cavity. In section the tenotome may be passed along its anterior or posterior surface, and if the point is kept in contact with the muscle, division is easily effected without complication.

The deltoid is inserted into the middle of the outer surface of the shaft of the humerus; its origin is so extensive as to give it the functions of several muscles. Section may be made of different parts of its insertion according as it may be necessary to relieve contraction; the anterior portion by inserting the tenotome near the insertion from before backwards along internal surface and cutting to the skin, and the posterior margin by a reverse movement.

The latissimus dorsi and teres major are inserted into the posterior margin of the bicipital ridge, and form the posterior wall ot the axilla; they depress the arm and draw it backwards. Section may be made of the combined muscles by passing the tenotome along either surface, turning its edge to the muscles and dividing with a sawing motion.

TENOTOMY IN THE LOWER LIMBS.

The distortions of the lower limb, due to contractions of the muscular system, form an important part of orthopædy. The different forms of club-foot and hand are due largely to this cause, and are remedied by restoring the balance of muscular forces.

The flexor longus digitorum affects the toes so as to require division, only when its contraction aids in causing or maintaining other distortions; it lies in such immediate relations with the tibialis posticus behind the malleolus, that if the knife is pushed a little deeper when behind the latter tendon, it will include the tendon of the former muscle, and both may be divided at the same operation; the point of the knife should be moved about as little as possible to avoid wounding the posterior tibial artery.

The flexor longus pollicis may require section to liberate this part of the foot, so important in every act of walking. It may be divided on the first phalanx,[1] or near the inner edge of the foot, where it can be made to project by strong extension of the toe. The point of division should depend upon the prominence of the tendon; by carefully passing the tenotome along the tendon, the plantar arteries will escape injury.

The extensor longus digitorum may fix the toes in a state of extension, or, by contraction, may elevate the anterior part of the foot. In the former case, section of separate tendons should be made on the dorsum of the metatarsus where there are neither important arteries nor nerves; the extensor of the great toe often requires section also; the skin may be pinched up and the tenotome passed between it and the tendon, and division made towards the bone. In the latter case section should be made where the tendons pass over the ankle; enter the tenotome close to the inner border of the tendon made tense, pass it outwards, and when the point is at the extremest border turn the edge upwards.

The extensor proprius pollicis has upon its internal border below, the anterior tibial vessels and nerves and dorsalis pedis artery. Section may be made through the same puncture as that used for section of the long flexor of the toes, the point of the knife being turned inwards, and carried no farther than the internal border of the tendon to avoid the vessels and nerve. Or, being made tense, the knife may be inserted on its inner margin and passed outwardly.

The tibialis anticus passes from the annular ligament of the ankle over the internal surface of the tarsus, and is inserted into the inner and under surface of the internal cuneiform bone and base of the metatarsal of the great toe. In talipes varus it is placed very much to the inner side, and passes obliquely downwards across the inner malleolus, inclined backwards towards the internal cuneiform bone, which occupies a lateral position, owing to the altered relation of the scaphoid bone. The tendon can generally be easily felt, except in fat infants; it should be divided a little above its insertion as it crosses the ankle-joint.

---

[1] J. Syme.

The tibialis posticus passes through a groove behind the inner malleolus with the tendon of the flexor longus digitorum, but in a separate sheath, then through another sheath over the internal lateral ligament, beneath the calcaneo-scaphoid articulation, and is inserted into the tuberosity of the scaphoid and internal cuneiform bone.[1] The posterior tibial artery lies behind it. In talipes varus the tendon at the point of division, just above the inner malleolus, is relatively more forward than in the healthy foot, and in the second part of its course, between the malleolus and its insertion into the scaphoid, the tendon does not pass beneath the inner malleolus, and then obliquely downwards and forwards to its insertion; but, on the contrary, passes directly downwards to the scaphoid bone.[2] If the tendon is normal, divide it half an inch above the inner ankle; the posterior tibial artery lies posteriorly; make a puncture between the artery and tendon, turn the foot outwards, and cut towards the skin; the artery may often be pressed one side by the finger or by the nail of the left index finger. If the tendon is displaced, as in varus, the following is important: If neither the tendon nor the inner edge of the tibia can be felt, as is commonly the case in fat infants, a puncture made in the inner aspect of the leg exactly midway between the anterior and posterior borders, is a true guide to the position of the tendon at the point of section. Thrust the tenotome or a sharp-pointed knife straight down to the tendon, and open the sheath by a movement of its point; now insert a blunt-pointed knife beneath the tendon, which will at once be so fixed that it cannot be moved from side to side if it is between the tendon and bone; make a complete section of it.

The peroneus tertius is a part of the long extensor, and branches off to be inserted into the base of the fifth metatarsal. Section is readily made when the long extensor is tense by inserting the tenotome on its external margin and passing it inwards; or it may be divided at the same time with the long extensor.

The peroneus longus and brevis pass through the same groove behind the external malleolus, and are invested by a common fibrous and synovial sheath; the long peroneus then passes across the outer side of the os calcis, in a separate sheath, over the margin of the cuboid, across the foot to the base of the first metatarsal; the short peroneus passes on the outer side of the os calcis to the base of the fifth metatarsal bone. Section of these tendons may be made: (1) An inch above the base of the external malleolus, the tenotome entering from before backwards between the fibula and the tendons; or, (2) half an inch in front of the apex of the malleolus, where they may be made prominent and divided by a single puncture; or, (3) the long tendon could be divided at a point midway between the end of the malleolus and the tubercle of the cuboid, and the short tendon at the external border of the extensor brevis digitorum.

The tendo Achillis is about six inches long, commencing about the middle of the leg, and is inserted into the lower part of the tuberosity of the os calcis; it is separated from the deep vessels, by a considerable interval; the external saphenous vein runs along its outer side; section is made as follows: Place the patient on his stomach with the foot hanging over the table or bed; an assistant should put the tendon on the stretch by attempting to flex the foot; introduce the tenotomy knife obliquely downward with its flat surface parallel with the tendon, close to its inner or outer edge, as most convenient, when the tendon is prominent; but when the tendon is deep, enter the knife on the fibular side to avoid the possibility of puncturing the posterior tibial artery; carry the knife to the opposite side, depressing the handle to a horizontal direction; now turn the cutting edge towards the tendon and divide it transversely from the internal to its external surface; close the wound with a compress fixed by adhesive strip and bandage. If the foot is immediately restôred, it must be retained in position by a proper shoe or by adhesive strips passed around the anterior part of the foot, and fastened to the upper part of the leg. If reduction is to be gradual, these appliances should not be resorted to in three or four days.

---

[1] H. Gray.

[2] W. Adams.

The biceps flexor cruris is inserted into the head of the fibula, and forms the external hamstring; the external popliteal nerve lies close to its internal border. Place the patient in a prone position, extend the leg firmly, and recognize the tendon; enter the tenotome an inch above the head of the fibula, on its inner border, inclining it at first outwards, until its point passes under the tendon; then depress the handle to the horizontal, and when its point is felt on the opposite side, turn the edge upwards towards the tendon and divide.

The semi-tendinosis, semi-membranosis, gracilis, and sartorius form the inner hamstring, and are inserted upon the inner and anterior surface of the tibia; the nerves and vessels of this region lie quite external. The patient being in a prone position, enter the probe-pointed knife close to the outer side of the tense hamstring to avoid the vessels and nerves of the ham, incline it inwards towards the median line of the body as it passes under the muscles, and until its point is felt on the inner side; now depress the handle and divide the structures towards the skin; the section may be limited to the semi-tendinosis and membranosis, or by deeper penetration all the tendons and muscles forming this group may be safely divided.

The quadriceps extensor cruris is composed of the rectus, vastus externus and internus, and crureus; the tendon is inserted into the tubercle of the tibia through the medium of the patella and the ligamentum patella; a large bursa lies under the conjoined tendons above the patella. Section above the patella is made as follows: pinch up a fold of skin parallel with the ligament, pass the tenotome through to the tendon, but do not penetrate too deeply, carry the blade along the anterior surface under the skin: turn it towards the tendon, and with a sawing motion cut until all resistance ceases; effectually close the wound, and do not attempt flexion until the repair has begun.

The pectineus is situated at the anterior part of the upper and inner aspect of the thigh, extending from the ilio-pectineal line of the pelvis to the rough line below the trochanter minor; it is an adductor of the thigh and may be divided as follows:[1] While one assistant fixes the pelvis, and a second straightens the contracted thigh, recognize the tense and elevated tendon of the muscle and pass a long blunt tenotome blade under it from the external side, an inch and a half below its origin; with a few passes of the blade the entire muscle is divided towards the skin, or the section may be made from the skin.

The adductor longus lies on the same place as the pectineus; it arises by a flat narrow tendon from the angle of junction of the crest with the symphysis, where it may be readily severed. Abduct the thigh and make the muscle prominent near its insertion. Pass the tenotome from without downward and inward, until the muscle is passed; then cut with a sawing motion towards the skin until the contracted tissue is divided.

The tensor vaginæ femoris is a short, flat muscle arising from the anterior part of the outer lip of the crest of the ilium, and from the outer surface of the anterior superior spinous process, and terminates in the fascia lata of the thigh, one-fourth down the external aspect of the thigh. It is easily divided by making it tense and passing a tenotome on either border about an inch from its origin, and cutting towards the skin.

The sartorius arises by tendinous fibres from the anterior superior spinous process of the ilium, and the upper half of the notch below it. Make a section of its tendon thus: An assistant strongly abducts the thigh which makes the muscle prominent; pass the long blunt tenotome under the muscle on its external border two and a half inches from its origin and cut towards the skin.

TENOTOMY IN THE TRUNK.

Many of the muscles in the region of the back have been divided to relieve curvature of the spine.[2] The first effect of division of contracted muscles, as the latissimus and longissimus dorsi in lateral curvature, was in some cases, apparently, very beneficial instantly.[3] But in no instance has the operation itself produced a cure, its effect being simply to take off, either in part or whole, the power of muscles engaged in maintaining the curvature, and thus placing the spine in a condition to be more easily influenced by mechanical and physiological causes.[4]

The multifidus spinæ consist of a number of fleshy and tendinous fasciculi which fill up the groove on either side of the spinous processes from the sacrum to the axis. The tension of the deep-seated layer of muscles of the back is weakened by dividing the thickest part of this muscle, as it lies comparatively superficial upon the dorsum of the sacrum opposite the posterior superior spine of the ilium;[3] pinch up the skin so that the fold is parallel with the spine; pass the tenotome upon the surface of the muscle, and cut towards the spine.

The longissimus dorsi and sacro lumbalis are portions of the erector spinæ; the former is the inner and larger portion, and is inserted into the tips of the transverse processes of the dorsal vertebræ, and into seven to eleven ribs; the latter is the external and smaller portion, and is inserted into the angles of the six lower ribs. The tension of the middle layer of spinal muscles is relieved by dividing these muscles in the lumbar region near their origin;[1] operate as above.

---

[1] F. Stromeyer.

[2] Guérin.

[3] Report of Committee on Guérin's Practice.

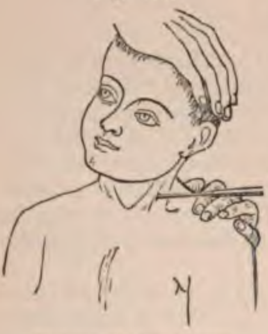
[4] R. Hunter.

The latissimus dorsi covers the lumbar and lower half of the dorsal regions, and is inserted into the bicipital groove of the humerus. The muscle is made tense by elevating the shoulder forcibly, and may be divided as follows:[2] Select a long, strong tenotome; pass the point under the anterior edge of the muscle, nearly opposite the angle of the scapula, and along the under surface; now turn the edge towards the muscle and cut with a short sawing motion, the thumb being pressed upon the tightly drawn band; turn the knife upon its side and withdraw it, closing the wound with the thumb; dress the wound with adhesive plaster and firmly adjusted roller.

The trapezius has one origin from the superior curved line and protuberance of the occipital bone. In lateral deviations of the head this muscle may become permanently contracted and require division at its cranial origin. The muscle being made tense by carrying the head to the opposite side, enter the tenotome below the occipital protuberance, pass its blade along the external surface of the muscle, then turn its edge to the muscle and divide the contracted tissue.

The sterno-cleido-mastoid muscle has its origin from the upper part of the sternum by a flat tendon, and from the sternal third of the clavicle by fleshy fibres; behind it are the carotid and subclavian arteries, and internal jugular vein. Division of this part of the muscle is necessary in distortion of the head, wryneck or torticollis, when it depends upon unyielding contraction of the sterno-mastoid without caries of the spine. In some cases only the clavicular portion needs to be divided. The operation is perfectly free from danger, if carefully performed, since the muscle stands out well from the vessels below it, which are again separated by a strong membrane.[3] A separate puncture should be made for each portion of the muscle. An assistant should put the head on the stretch so as to render the muscle prominent (Fig. 246), pass a long tenotome closely along the surface of the clavicular fibres about half an inch above the clavicle, turn its edge towards the muscle and divide completely; enter the tenotome in the same manner and divide the sternal origin.

Fig. 246.



Division of sterno-cleido.

---

[1] R. Hunter.
[2] L. A. Sayre.
[3] T. Holmes.

IV.

THE CIRCULATORY SYSTEM.

THE HEART; THE ARTERIES; THE CAPILLARIES; THE VEINS; THE LYMPHATICS.

CHAPTER XXIV.

THE INJURIES OF THE CIRCULATORY SYSTEM AND SPECIAL OPERATIONS.

I. INJURIES OF THE HEART.

WOUNDS may involve only the pericardium, or they may penetrate to the walls of the heart, or even reach its cavities. The instruments with which they are inflicted are projectiles and pointed bodies, as needles, pins, knives. The symptoms are, hemorrhage from the wound, more or less free; sudden convulsive movement; pallor; faintness; sighing respiration; cold extremities; small, unequal, and intermitting pulse, and acute pain in the sternal region. Death may be immediate, caused by the sudden arrest of the heart's action, either from shock or the accumulation of blood in the pericardium, or life may be prolonged for days, or complete recovery may follow. The treatment[1] should aim (1) to favor the formation of a coagulum in the wound; close it with antiseptic dressings at once, and do not reopen unless the collection of blood in the pericardium becomes so great as to cause intense dyspnœa and interfere materially with the action of the heart; place the patient in a recumbent position, and enforce the strictest quiet and silence; freely expose the chest to the air, and if there is a tendency to hemorrhage, apply cold, as ice; remove any foreign body when it can be effected without difficulty, but use no violence in attempting to withdraw it lest fatal hemorrhage ensue; (2) prevent the separation of the clot; persistent rest of the body in the recumbent position, and removal of all sources of irritation, local or general, must be enforced for a considerable period; venesection is not required, but digitalis to moderate the force of the heart's action, acetate of lead to favor coagulation of the blood, and hypodermic injections of morphia to allay excitement, will be required; interfere with the wound as little as possible; (3) to control inflammation; leeches, perfect rest, low diet, with calomel and opium, are most useful; in all cases a broad flannel bandage applied around the thorax gives the greatest comfort. If the præcordial dulness becomes very extensive from serous effusion into the pericardium, or if still later, there is evidence of a collection of pus, it will be expedient to draw off the fluid with a trocar or aspirator, the cicatrix being the guide to the point of puncture. When a foreign body remains and the diagnosis has been satisfactorily established, extraction by incision has been undertaken with success, as follows:[1] Chloroform being given, a spot was selected at which each impulse of the heart gave the feeling of something firmer than the surrounding tissue; the skin and subcutaneous structures were divided, when the extremity of the needle was brought into view on a level with the surface of the intercostal muscle moving with each impulse of the heart, and describing a curve; the needle was now seized and removed.

---

[1] J. F. West.

II. INJURIES OF THE ARTERIES.

The deep situation of arteries, and their unexposed position at joints, protect them from the more common injuries.

Contusion may be so slight as to cause but temporary disturbance of the circulation, or so severe as to lead to closure of its calibre, or destruction of its coats. Closure is due to the formation of a thrombus,[2] and is liable to be followed by gangrene of the parts supplied by the artery. If a lesion of the coats finally occurs, a pulsating tumor, traumatic aneurism, forms. The treatment of contusion depends upon its secondary effects; if gangrene follows amputation will be required when the disease has become limited; if an aneurism appears it must be treated according to the established rules.

Rupture of the coats of an artery occurs when the limb is subjected to a violent strain. The lesion may involve the internal coat only, or the external coats without lesion of the internal coat, or all of the coats may be torn through. The symptoms depend upon the nature of the lesion; if the internal coat alone is ruptured, there is sudden pain in the part, and the circulation ceases. The artery is finally closed, as in ligature at the point of injury. Lesion of the external coats is followed by pain, and a pulsating tumor, an aneurism. If all the coats are ruptured, extravasation to a variable extent takes place into the surrounding tissues, with diffused swelling. If the blood is effused in large quantities from a ruptured artery, of an extremity, as from the popliteal, which is most frequently injured, gangrene will soon follow. If the extravasation takes place slowly, or to a limited extent, the conditions of an aneurism are gradually developed. The treatment must depend upon the degree of injury to the artery; if blood is effused in small quantities, rest, position, and cold, with pressure upon the distal portion of the trunk, may effect a cure; if there is large effusion, without coldness of the limb below, apply a tourniquet, or the elastic bandage above, cut down upon the ruptured artery, turn out the clot, find the rent, and tie above and below; if the extravasation is excessive, followed by coldness and numbness of the extremity, amputate at once above the seat of injury.

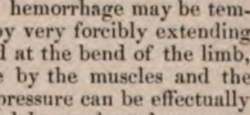
---

[1] G. W. Callender.

[2] R. Moxon.

Penetrating wounds by a small instrument, as a needle, will heal without hemorrhage or other symptom. If the instrument is large, hemorrhage may be immediate, or the elasticity of the coats may close the wound temporarily, but it is liable to re-open and bleed. If the wound is incised it may be transverse, oblique, or longitudinal to the axis of the vessel; it may partially or wholly divide the artery; in complete division there is less liability to hemorrhage than in partial division, owing to the contraction and retraction in the former case; longitudinal incised wounds tend to unite without dressing. The treatment should be as follows: (1) Remove any foreign body from the wound which might interfere with the closure of the artery; (2) arrest the hemorrhage according to the following general rules:—

Fig. 247.



Compress for artery.

(*a*) If the wounded artery is in an extremity, the hemorrhage may be temporarily controlled, either by strongly flexing, or by very forcibly extending the limb; in the former case the artery is compressed at the bend of the limb, and in the latter compression is made in its course by the muscles and the fasciæ; (*b*) in all cases of punctured wounds, when pressure can be effectually made, and especially against a bone, it should be tried by graduated compression over the part injured (Fig. 247), and, if necessary, on the artery above and below the wound; if it is in an extremity, bandage the whole limb, the motions of which should be effectually prevented, and absolute rest must be enjoined, especially if the artery is large; continue this treatment for two, three, or more weeks, according to the nature of the injury; (*c*) if the artery is small, like the temporal, divide the vessel, when it will be enabled to retract and contract; and the bleeding will in general permanently cease under pressure, especially when it can be applied against the bone. If the artery is of a larger class, and continues to bleed, it should be sufficiently exposed by enlarging the wound; a ligature should be applied above and below the opening in the vessel, which may or may not be divided between them. If it is determined to apply a ligature, it is a rule that no operation is to be done for a wounded artery in the first instance but at the spot injured, unless such operation not only appears to be, but is impracticable. No operation should be performed if bleeding has ceased, unless its repetition would endanger life.[1]

Wounds of certain arteries require special treatment, as follows:—

In the Neck. (1) When the internal carotid is wounded through the mouth, place a ligature above and below the opening made into it;[2] the rule which generally obtains among surgeons is to apply a ligature to the common carotid; (2) when any one of the branches of the external carotid has been wounded, tie both ends at the part wounded; if this is impracticable, and the hemorrhage demands it, the trunk of the external carotid should be ligated, not the common carotid; (3) a wound of the internal carotid artery, when near the bifurcation of the common carotid, will require a ligature to each; (4) an antiseptic ligature may be placed on the internal or external carotid, close to the bifurcation; but if the wound of either vessel should encroach on the bifurcation, one ligature should be applied on the common trunk, and another above the part wounded; but as neither of these would control the collateral circulation through the uninjured vessel, whichever of the two it might be, a third ligature should be placed on it above the bifurcation; (5) a wound known or suspected to be of the vertebral artery should be treated either by direct pressure or by ligature of the vessel in the wound;[1] (6) never place a ligature on the subclavian artery above the clavicle for a wound of the axillary below it.

---

[1] C. F. Maunder.

[2] C. J. Guthrie.

In the upper limb. (1) In punctured wounds of the arteries of the arm and forearm apply pressure to the part injured, and a bandage to the limb generally; but when the bleeding cannot be restrained in this manner, a ligature should be applied above and below at the part injured whether the artery be radial, ulnar, or interosseal; (2) when the ulnar artery is wounded in the hand, which is comparatively a superficial vessel, pressure may first be tried; but failing, apply ligatures upon each extremity; (3) when the radial artery is wounded in the hand, in which situation it is deep seated and the bleeding end or ends of the artery can be seen, place a ligature on each; if this cannot be done, search by incisions through the fascia, as extensively as the situation of the tendons and nerves in the hand will permit, that the bleeding point may be fully exposed, remove all coagula, lay a piece of lint, rolled tight and hard, of a size only sufficient to cover the bleeding point, upon it; place a second and larger hard piece over it; and so on, until the compresses rise so much above the level of the wound as to allow the pressure to be continued and retained on the proper spot, without including the neighboring parts; apply a piece of linen, constantly wet and cold, over the sides of the wound, which should not be closed, to allow of the free escape of blood. It is desirable to ligate the brachial artery rather than the radial and ulnar in secondary hemorrhage of hand.[2]

In the lower limb. (1) The anterior tibial artery is to be tied at that part of its course at which it may be wounded; if the wound is very near its origin, or just behind the interosseous space and ligament, and the bleeding free, make an incision on the forepart of the leg, and if the bleeding point is so deep between the bones as not to admit of two ligatures being placed on the artery above and below it, make an incision through the calf of the leg, where the artery can be secured without difficulty; (2) the posterior tibial, or the peroneal artery, or both, if wounded at the same time, are to be tied through a free incision in the calf; (3) the popliteal artery should be secured by ligature, only when bleeding; (4) when a wound of the femoral artery or its branches occurs, and the bleeding cannot be restrained by a moderate but regulated compression on the trunk of the vessel, and perhaps on the injured part, recourse should be had to an operation, by which both ends of the wounded artery may be secured by ligature; and the impracticability of doing this should be ascertained only by the failure of the attempt; if the lower end of the artery cannot be found at the time, the upper only having bled, a gentle compression maintained upon the track of the lower may prevent mischief; but if dark-colored blood should flow from the wound, which may be expected to come from the lower end of the artery, and compression does not suffice to suppress the hemorrhage, the bleeding end of the vessel must be exposed, and secured near to its extremity; (5) wounds of the branches of the internal iliac require that a ligature should be applied to both cut extremities, and not to the arteries at their origin.

III. THE VEINS.

The veins are liable to traumatic lesions, but owing to the quiet flow of the blood-current, and the compression of surrounding tissues, the effusion is rarely serious. When, however, injuries of deep-seated veins, especially those communicating with cavities, occur, the hemorrhage may be dangerous.

Contusion[3] causes the rupture of a greater or less number of superficial veins, followed by the extravasation of blood into the sur-

[1] T. Holmes. [2] C. F. Maunder. [3] T. Billroth.

rounding tissues, or into cavities. The more vascular and yielding a part, and the more severely contused, the greater the extravasation; if the blood escapes slowly it forms a passage-way between the connective-tissue bundles, especially subcutaneous connective tissue and muscles, the wounds being rough and ragged, obstacles are presented to the free escape of blood, and fibrinous clots form, extending into the calibre of the vessel, causing mechanical closure by thromboses. The escaped blood undergoes various changes, namely, the fibrine coagulates, the serum enters the connective tissue and is reabsorbed, the coloring matter leaves the blood-corpuscles and is distributed in solution among the tissues, passing through various metamorphoses, with change of color, till it is transformed into hematoidin; the fibrin and blood corpuscles for the most part undergo disorganization and are reabsorbed. Immediately after the accident apply compression as accurately as possible to prevent further effusion; add ice, or cold lotions, to prevent inflammation. Later, employ uniform compression, with moist antiseptic dressings to promote absorption. If there is no marked change in two weeks, to compression add painting with tr. iodine daily. If the part becomes hot, red, and painful, make a free incision down to the effused blood, carefully remove all the clots, cleanse the cavity with bichloride solutions, apply drainage-tube to the deepest part of the cavity, and close the incision with an interrupted catgut suture; apply antiseptic compresses.

Wounds of veins are of frequent occurrence, and generally of slight importance. They are recognized by the flow of dark blood without jet or impulse. They heal readily, owing to the easy approximation of the cut surfaces, and the prompt formation of the blood clot in the wound and vessel. The danger is threefold, namely, hemorrhage; the entrance of air; inflammation in the connective tissue with the formation of thrombus. Ligate the vein, if exposed and accessible, or use torsion or acupressure; elevate the limb or part, and remove all constriction above the wound; apply firm compression over the wound; prevent inflammation by the use of cold.

IV. THE LYMPHATICS.

Wounds[1] of the lymphatic vessels occur in every considerable wound of the soft tissues, but their injury is concealed by the flow of blood, and the lesions of other vessels. It is only by the subsequent inflammation that their lesions become important. From the margins of the wound fine red striæ run longitudinally towards the glands, which swell and become very sensitive, accompanied by fever, loss of appetite, and general depression. The inflammation may terminate in resolution, or the limb may become red and œdematous, with high fever, and even chills, and fluctuation soon after announces the formation of pus in the glands or cellular tissue. The early treatment should be cleansing and disinfection of the wound to prevent the further absorption of septic fluids; rest; active purgation; local applications of lead and opium lotions, or inunctions of mercurial ointment; wrapping the limb in cotton, the limb meantime being elevated and wrapped so as to maintain an even temperature. If pus forms it must be evacuated early; if it is in a gland, and healing does not progress satisfactorily, use hot, moist applications, lest the poison again extend from the gland.

---

[1] C. H. Moore; T. Billroth.

V. ARTERY AND VEIN.

Wounds may penetrate an artery and adjacent vein, or the lesion of the two vessels may occur spontaneously, and lead to an admixture of the two currents, creating a form of aneurism.

Arterio-venous aneurism is described as of two kinds: (1) Aneurismal varix, when the two vessels are so united at the seat of lesion that the arterial current passes directly into the vein without the intervention of a sac (Fig. 248); (2) varicose aneurism, when there is a sac interposed between the artery and vein (Fig. 249). The symptoms are well defined; the vein pulsates, enlarges, becomes tortuous, and has a fusiform shape; there is often a harsh rasping sound on the proximal side; the mass is soft and compressible. The tendency of the tumor is to an arrest of growth; when aneurismal varix of the upper extremity produces no pain, and leads to no rupture, it may be left untreated or simply met with palliative measures; but varicose aneurism always requires treatment.[1] At an early period the disease may often be cured by pressure simultaneously made on the main artery and on the orifice of communication by two persons, one pressing lightly on the point at which the arterial stream enters the tumor, with sufficient force to suspend the cooing murmur, the other compressing the artery at some convenient spot above the tumor.[2] If the tumor enlarges and radical treatment is necessary, the ligature should be applied to the vessels at the seat of lesion.[3] An anæsthetic being given, apply the elastic bandage to the limb; make a long and free incision over the tumor; lay open the sac to its full extent, and remove the blood; pass a probe through the orifice into the sac and lay it open; now find the opening into the artery, and apply a ligature to that vessel above and below the lesion;[4] the artery may be tied outside of the sac in small tumors; if necessary, the vein may also be ligated.[4] Both the artery and vein have been successfully tied above and below the tumor.[5]

Fig. 248.

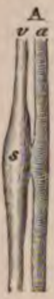
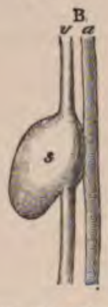


Fig. 249.



Different forms of varicose aneurism. *A*. The artery and vein directly communicating. *B*. The dilation being more in the vein.

---

[1] R. Barwell.

[2] T. Holmes.

[3] W. H. Van Buren.

[4] F. H. Hamilton.

[5] T. Annandale.

CHAPTER XXV.

DISEASES OF THE CIRCULATORY SYSTEM AND SPECIAL OPERATIONS.

I. THE HEART.

Inflammation of the serous pericardium, if of traumatic origin, may result in the formation of pus in its cavity, or, if idiopathic, may terminate in an accumulation of serum. Whatever may be the nature of the distending fluid, if it lead to great embarrassment of the heart's action and the respiration, and all the usual remedies have failed to give relief, removal by the aspirator, or trocar and canula, may with proper precautions be undertaken.

II. THE ARTERIES.

Arterial thrombosis is the formation of blood-clot, or thrombus, in an artery, and is caused by retardation of the blood-current, or irregularities on the inner wall of the vessel, which increase the friction between it and the passing blood; they are laminated when formed by an intermittent, gradual, and long-continued coagulation, as in aneurism, and non-laminated when they originate in sudden coagulation of an isolated mass of blood, as after ligature of an artery. The clot may organize and become a member of the series of vascular connective tissues, or it may soften, giving rise to abscess or embolism.[1]

Embolism consists in the occlusion of a vessel by some substance which cannot pass through it, as a mass of fibrin from the valves of the heart, or from a diseased artery. The most marked symptom is a sudden and severe pain in the part supplied by the occluded artery, with numbness and tenderness; pallor and coldness follow, and in severe cases, dry gangrene or an aneurism. If the collateral circulation is active, gangrene may be prevented, or very much limited. The disease is more frequently met with in the extremities of old people. The treatment should aim to increase the circulation of the part by warmth, externally applied, gentle friction, and moderate elevation. If gangrene occurs the part should be dressed with iodoform, naphthalin, carbolic acid solution, or other disinfectants. When the line of demarcation is well formed amputation may be performed, but it should be delayed until the separation of the dead part is well defined.

Cirsoid aneurism is the dilatation and lengthening of an artery, giving it the appearance of varicosity; it may appear over the occiput, vertex, temples, or in the extremities; it usually lies just under the skin, and is readily recognized by the tortuous pulsating artery or arteries.[1] The treatment should be directed to the prevention of the further enlargement of the artery by elevating the part as much as possible, douches of cold water followed by supporting appliances, as elastic bandages, laced stockings when the lower extremity is affected. When the tumor is inconvenient, or from other causes it is necessary to undertake a radical cure, the antiseptic ligature of the trunk artery leading to it, though an exceedingly uncertain measure, is perhaps the best, the dilated vessel itself being too much altered in structure to bear the ligature with safety.[2]

---

[1] E. Rindfleisch.

Aneurism by anastomosis differs from the preceding only in the larger number of arteries involved and the final implication of capillaries and veins. They are large, irregular, lobulated, pulsating masses, in which a considerable bruit can often be heard, and numerous large vessels can be traced into them on all sides; the capillaries share in the enlargement, and the veins thus receive the pulsation; as the arteries enlarge, their coats become thin, so that it is impossible to distinguish between the arteries and veins around the tumor; their favorite seats are the scalp near the ear and the lip.[2] Excise the mass, if small and favorably situated, as on the lip, cutting wide of the growth;[3] apply the ligature subcutaneously, as in nævus, when the tissues admit; apply a ligature to the trunk of the main artery when the growth is favorably located, as to the external carotid when the disease is in the temporal artery, to the common carotid when the orbit is the seat of the disease; electro-puncture should be employed in severe cases, especially when deeply situated;[4] coagulating agents, as perchloride of iron, may be injected, care being taken to prevent the escape of coagula by accurate pressure around the growth; amputate when the disease affects seriously the bones of the extremity.

Atheroma[5] consists in a chronic inflammation of the inner coat of the artery; the predisposing causes are advanced age, alcoholic stimulants, gouty diathesis; and the localizing cause, mechanical irritation of the impact of the blood on points of curvature and bifurcation of the artery; the change consists in a thickening of the membrane itself, a proliferation in and from the connective tissue of the intima, causing an increase of its bulk, and culminating in an inflammatory overgrowth. Retrograde tissue-metamorphosis now begins, which may terminate in fatty degenerations of the cells, combined with solution of the intercellular substance, and the formation of an atheromatous abscess; or the intercellular substance may become impregnated with earthy salts, a calcification, and form plates of variable size and form. The result of these changes is diminution of the calibre of the vessel, which leads to diminished force of the circulation beyond the lesion, and increased force on the proximal side. Two effects may follow: (1) lessened nutrition, and even gangrene of the extremity supplied by the obstructed artery; or (2) yielding of the vessel, causing aneurism. The treatment is limited to the effects of the disease. If gangrene occur, amputation must be performed only when the line of demarcation is well established; if the operation is undertaken too early, re-amputation may be required, owing to the extension of the disease. Aneurism requires special treatment.

---

[1] T. Billroth.
[2] T. Holmes.
[3] Heine.
[4] J. Spence.
[5] E. Rindfleisch; R. Moxon.

Aneurism occurs when the coats of an artery, weakened by atheroma or calcification, yield at the point of greatest pressure of the blood-current, and give rise to a tumor. The shape and size which it assumes depend upon the number of coats involved, the location of the lesion, and the surrounding tissues. It may be invested by all of the coats of the artery, true or fusiform aneurism; by one or more coats, false or sacculated aneurism; or all the coats may have ruptured, diffused aneurism. The diagnostic signs are: (1) A tumor in the course of an artery; (2) expansive pulsation, synchronous with the heart; (3) a bruit; (4) cessation of pulsation and diminution of tumor on compressing the artery on the proximal side. There are many sources of error in these signs, and hence they must be carefully studied as a group; if doubt remains, puncture with a hypodermic syringe, or the needle of an aspirator, and examine the contents.

The various methods of treatment aim at the consolidation of the blood in the tumor, and obliteration by absorption or organization of its contents. This may be effected by operations upon the tumor and upon the arteries. The operations upon the tumor are designed to diminish the force of the circulation, or interrupt it altogether, in order to effect coagulation of its fluid contents.

Manipulation[1] is practised to displace a clot which, escaping from the cavity into the artery, is carried to a lower point where it lodges, and plugs the artery, and leads to a set-back and interruption of the current through the aneurism. It has been successfully employed in popliteal, femoral, carotid, and subclavian aneurism, and is, undoubtedly, a justifiable measure in tumors which cannot be operated on without very great danger, and are not near to bursting, and in which there is evidence of blood-clot.[2] Fatal results have followed this operation when practised on aneurisms of the neck from embolism of the brain.[3] Place the flat end of the thumb on the prominence of the tumor, and press until the fluid contents escape, and the upper surface of the aneurism is pressed against the lower; now give a rubbing motion to the thumb so as to cause a friction of surfaces within the flattened mass.

Injection of coagulating agents has proved successful; but as this method is always liable to cause dangerous inflammation, gangrene, embolism, it is not justifiable where compression can be used.[4] The agent preferred is a neutral solution of perchloride of iron, one part of the salt to fifteen or twenty of distilled water; the amount should not exceed five drops to every ounce of blood that the sac is estimated to contain.[5] Compress the artery above and below the tumor so as to completely arrest the circulation; introduce the needle of the hypodermic syringe perpendicularly to the tumor until the extremity is within the cavity of the aneurism, as will appear by the escape of arterial blood; the canula, containing fifteen to twenty drops of the fluid, is screwed on to the needle; now inject drop by drop, occasionally changing the position of the extremity of the needle to form new centres of coagulation; when the tumor has become sufficiently firm, draw the piston to suck up any free acid which would irritate the soft tissues, and carefully withdraw the instrument; continue compression on the cardiac side for an hour or more. Parenchymatous injections of ergotine[6] have proved useful; or, take fl. ext. ergot, one part, rectified spirit, glycerine, each, one and a half parts; of this mixture inject ten to fifteen minims in close proximity to, but not into the sac.[1]

---

[1] Sir W. Fergusson.
[2] T. Holmes.
[3] F. Esmarch.
[4] Marsacci.
[5] Valletta.
[6] Von Langenbeck.

The **elastic bandage** has been successfully employed, the object being to completely control the circulation of the limb and tumor for a time. Apply the elastic bandage from the extremity upward above the tumor, but lightly over the aneurism; apply the elastic tubing around the limb over the highest turn of the bandage, and remove the bandage; the limb is now pallid and the tumor pulseless; after fifty minutes, apply compression to the main trunk, and remove the tubing; continue pressure, if necessary, in an intermittent manner for a day or two, when the cure will be found complete.[2]

Flexion[3] was introduced into practice by its being observed that popliteal aneurisms ceased to pulsate on flexion of the leg on the thigh. It has been successful in aneurism at the bend of the elbow, knee, and hip, and is indicated in small aneurisms, so situated that the pulsation and bruit are suspended by bending the joint;[4] it need not be extreme nor painful, nor need the limb be bandaged or confined in any way in many cases, as voluntary flexion, the patient being allowed to change the position of the limb slightly, will sometimes succeed when forced flexion would not be tolerated; as flexion acts by retarding the blood-stream and displacing clot, pressure may be combined in the treatment; forced flexion may cause rupture of the sac.[5] Bandage the limb from the extremity nearly to the joint, then flex the limb firmly and turn the roller around the flexed part, thus fixing the forearm or leg in a flexed position.

Foreign bodies have been introduced into the cavity of the aneurism for the purpose of inducing coagulation by whipping the blood; the cases selected were most unfavorable, and all were fatal, but not from the effect of the operation. Iron wire,[6] horse hair,[7] carbolized catgut,[8] are the agents which have been used; they were introduced through a fine canula. Introduction of needles, cold or hot,[9] has frequently been resorted to, but without much practical result; they have been repeated every ten minutes, for an hour, with pressure.[10] In other cases needles have remained in the aneurism for several hours and even days.[11] An operation for the cure of abdominal aneurism, high up on the aorta, is thus recorded.[12] Abdomen was opened and a silver copper wire half a millimetre in thickness, passed through a fine canula and piloted by a trocar, was thrust into the aneurism; after passing more than two yards of wire into the sac, the end of it was pushed in, and the canula withdrawn; on touching the point of puncture with carbolic acid, not a drop of bleeding occurred; colon, stomach, and omentum were replaced and the abdominal wall closed with nine interrupted sutures; wound healed by first intention and the condition of the patient was at once improved; the tumor, which was as large as the head of a new-born child, by the seventieth day was reduced to the size of a walnut, and the aneurism considered cured; on the ninety-second day after the operation, the patient died of rupture of the aorta below the sac, attributed by the operator to ischæmia of the tunics of the aorta, due to compression and changes in the interior of the sac.

Electrolysis is designed to secure a gradual deposit of the layers of fibrin, and has proved successful in a fair percentage of cases,[13] for the most part of the extremities; abdominal and thoracic aneurisms have rarely been benefited; in the latter case, if the disease tends certainly to death and other methods have failed, electro-puncture would be justified.[14] Give an anæsthetic; begin with one or two cells; introduce into the aneurism two or three needles connected with the negative pole, while a sponge electrode connected with the positive pole is applied to the adjacent surface; the length of the application may be five to forty-five minutes; from one to four or five operations are usually sufficient.[1]

---

[1] R. Barwell.
[2] W. Reid.
[3] E. Hart; M. Mannoir.
[4] E. Hart.
[5] T. Holmes.
[6] C. H. Moore.
[7] R. J. Levis.
[8] Murray.
[9] E. Hohn.
[10] W. Mac Ewen.
[11] C. Heath.
[12] Loreta.
[13] A. M. Hamilton.
[14] H. I. Bowditch.

Operations upon the arteries are performed for the purpose of arresting the flow of blood into the aneurism, and thus promoting coagulation.

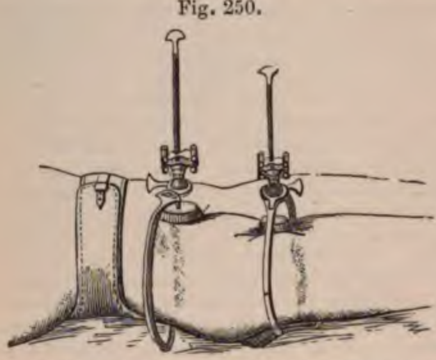
Ligation of the arterial trunk has long been the approved method of obstructing the circulation in an aneurism. The ligature has generally been some irritating, indestructible material, as silk, which, in its application, ruptured the internal coats, and then by slow degrees divided the external coat, and was cast off from the wound. The cure of the divided artery was effected by the organization of a clot, and the final repair of the cut ends; but this process is always liable to be interrupted; the clot may not organize and the cut ends of the artery may not repair, owing to the inflammation which the ligature creates. This result is followed by hemorrhage from the wound, always a dangerous complication. These dangers are very materially diminished by the use of an unirritating ligature, as silver or iron wire, which may remain long in the wound without causing inflammation. But the most perfect results are obtained when an unirritating and absorbable ligature is used, as carbolized catgut. The ligature need not be so tightly applied as to sever the coats of the artery, and the wound may at once be permanently closed. The course of repair consists in the union of the external wound without suppuration, the union of the opposed surface of the internal coat of the artery, the replacement of the old ligature by a new ligature of living tissue which strengthens the artery at the point of ligation. It follows that such a ligature may be applied where silk would ordinarily prove fatal, as in the vicinity of large trunks, and where a resulting inflammation would dangerously complicate the operation, as in proximity with serous cavities. The only defect in the method of applying absorbable ligatures is the liability of their absorption before the cure is completed; but this has been remedied by preparing the catgut so that it will remain firmly applied for a sufficiently long time and then undergo absorption without irritation. The rule, therefore, should be to select a ligature which is unirritating, and will be absorbed, and to apply it with antiseptic dressings. But if such a ligature is not at hand, the silk should be carbolized, and applied antiseptically. The several points of ligation are as follows: (1) On the cardiac side, near the tumor,[2] or near the first collateral branch, above the aneurism;[3] the latter point is always to be preferred when the artery is readily accessible, as the femoral, for popliteal aneurism; (2) On the distal side[4] when the artery cannot safely be reached on the cardiac side, as the subclavian or common carotid in innominate aneurism; (3) At its entrance into, and exit from, the aneurism, the old operation,[5] as in carotid aneurism at the base of the neck, or traumatic aneurisms.

Compression may be direct or indirect. Direct compression consists in pressure applied to the aneurism itself;[6] it has been successful in carotid aneurism compressed by a sponge.[7] In a small subclavian aneurism by binding a hollow India rubber ball filled with air.[8] This treatment is adapted to but few cases, and if employed sloughing of the skin must be avoided. Indirect compression consists in the application of pressure to the artery, on the cardiac side with a view to cause coagulation of the blood in the aneurism. Success depends on (1st) the regulation of pressure so that a continuous slight stream passes through the sac; (2d) avoidance of pressure (in some parts) on the vein; (3d) great care in preserving the skin in good condition at the point of pressure. This method is capable of curing the majority of surgical aneurisms, and when it fails, in no marked manner militates against the adoption of other measures.[1] To be successful, this pressure must be regular, efficient, and equable.[2] It may be digital or instrumental; the former when successful, is more rapid and less painful, and should be preferred in favorable conditions. In digital compression commence the treatment by preparing the patient with several days of rest and low diet to reduce the circulation; select three or four reliable assistants, who must be employed for four or five hours consecutively, each in rotation applying pressure for ten minutes at a time; the pressure must be steady and equal by the finger or thumb placed directly over the vessel, with just sufficient force to arrest the flow of blood and no more;[1] if the patient becomes restive, give anodynes; or it may be necessary to intermit to give the patient rest. The pressure of the fingers may be reinforced by placing a weight, as a bag of shot, upon the ends. The cure may be very rapid, even occurring in one and a half, two and a half, and three hours,[3] or it may be prolonged; pressure should not be given up unless after several days no impression is made, or the surface ulcerates. Instrumental compression may be made in a variety of ways, but in all cases the point used for pressure should, as far as possible, be small, like the finger ends, in order to make accurate pressure on the artery and avoid compression of the vein. A simple appliance is a bag or sack of sand or small shot, made tapering at one end, and suspended by an elastic band; tourniquet pads may be adapted to various forms of apparatus so as to make pressure at a single point or at several points allowing intermittent pressure (Fig. 250). If the treatment cannot be tolerated, or incipient gangrene at the point of pressure or in the extremity, appear, this method of treatment should be abandoned.

---

[1] Beard & Rockwell.
[2] Anel.
[3] J. Hunter.
[4] Brasdor.
[5] J. Syme.
[6] Heister.
[7] Ciniseli.
[8] T. Holmes.

Fig. 250.



Two compressors applied for femoro-popliteal aneurism.

Acupressure can be practised with safety upon arteries which are so much diseased that they are too brittle and friable to bear the strain of a ligature; in cases of aneurism where the artery is diseased for some distance above the sack, the vessel may be closed by an an acupressure-needle at a point where it would be inexpedient to apply a ligature; thus, an aneurism of the lower femoral may be treated with acupressure at the upper portion of the femoral, whereas, if treated by deligation, the ligature would have to be placed upon the external iliac artery, a much more serious operation.[4] Pass the needle under the artery and make a figure-of-8 with the thread.

Constriction[5] is made by the artery constrictor (Fig. 25), expose the artery at the point for constriction, and apply the constrictor as directed (p. 46); the internal coats being ruptured, remove the instrument and accurately close the wound; a clot forms, the current of blood is permanently interrupted, and the consolidation of the aneurism takes place.

III. THE VEINS.

Venous thrombosis is due to the same conditions which cause thrombus of an artery, namely, retardation of the circulation, or irregularities in the coats of the vessels. More frequently they are caused by acute inflammation of cellular tissues, especially under fascia, tense skin, or bone.[1] The thrombus forming at one point often extends by the deposition of fibrin to other branches until a large number, or a plexus of veins, is filled. The clot may be reabsorbed, or organized into connective tissue, or suppurate, forming an abscess, or undergo disintegration, giving rise to embolism.[1] The treatment is absolute rest, with applications of ice; friction with mercurial ointment to prevent embolism; early evacuation of purulent collections.[1]

---

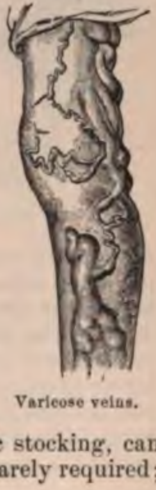
[1] T. Bryant. [2] T. Holmes. [3] J. Knight.
[4] J. C. Hutchison. [5] S. F. Spier.

Varices are veins in a state of permanent dilatation. Veins in certain localities, as in the plexuses of the true pelvis and its outlet, and in the superficies of the leg, undergo permanent dilatation, causing varix, phlebectasy. This change is the result of a local rise in the blood-pressure; the disorder is never restricted to a single and very marked dilatation of a vein, but always involves the moderate dilatation of an entire plexus, or of all the branches of a single trunk; the distension begins just above the valves, which, having to support a greater weight than usual, become incompetent, and the vein is stretched longitudinally; the fixed condition of both ends of the vein compels the elongated vessel to bend, forming zigzags, or become spirally twisted. The tendency to varices is individual, or inherited; hence the ordinary causes act upon existing predispositions. Dilatation may affect alike both the superficial and deep veins;[2] in the former case the disease is apparent, in the latter it is recognized by the enlargement of parts, the unusual weight, aching, and sense of weariness. In general, varices are merely causes of discomfort and inconvenience; but they may create disabilities so serious as to necessitate operations designed for their radical cure. The general plan of treatment is as follows: remove the causes of local blood-pressure; support the distended veins and restore their tonicity; operate only upon such varices as cause serious inconvenience or permanently disable the patient. The special treatment must vary with the particular class of veins affected, their condition, and the causes which created and maintain the varicose state.

The veins which more frequently become varicose and require radical treatment by operations are as follows:—

The varicose, internal saphena vein (Fig. 251), forms soft masses, or tortuous elevations of the skin on the anterior and inner aspect of the leg; the disease may involve a few branches or the entire plexus and the trunk above the knee. It occurs more often in persons who stand much; in women who have borne many children; and in those who have undue pressure upon some part of the main trunk. Palliative treatment, in the form of the elastic stocking, can be most satisfactorily employed. Operations are very rarely required;

Fig. 251.



Varicose veins.

---

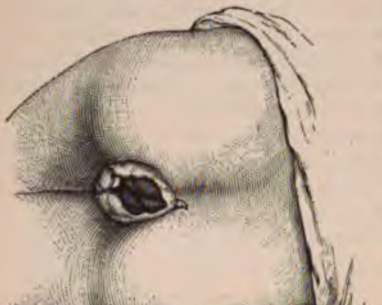
[1] T. Billroth.

[2] L. Verneuil.

those most approved are as follows: (1) Acupressure, raise the vein so as not to puncture it, pass two pins under it an inch apart, and twist a figure-of-8 silk ligature around the pins, or use rubber, or wire; now pass an asceptic tenotome under the vein and divide it subcutaneously; support the limb with a bandage; remove the pins in three to five days; incision may be delayed several days; (2) injections of coagulating fluids; use persulphate of iron with hypodermic syringe thus: apply a compress and roller on the vein above, the patient first standing until the vein is well distended; fill the syringe and then, pointing it upwards, force out a drop or two to expel the air; select several of the most prominent nodules and inject into each three or four drops; apply adhesive plaster over the punctures; retain the compress over the vein two or three days and enjoin perfect rest.[1]

The varicose hæmorrhoidal veins (Fig. 252) have their origin in congestion of the venous radicals in the lax submucous tissue of the rectum close to the anus; mucous catarrh and overgrowth of the mucous follicles follow; at a later stage the phlebectasy proceeds to the development of large plexuses of varicose veins which push the mucous membrane before them and form a ring of transverse rugæ round the anal aperture; the dilation finally concentrates at one or more points of these rugæ, which develop into rounded protuberances, and ultimately into fungoid tumors of considerable size; the chief part of the texture of a hæmorrhoid is spongy, being atrophied connective tissue, caused by the pressure of the distended veins kept up by the persistently increased tension in their interior; inflammation often occurs about these venous plexuses, resulting in induration or suppuration, and blood may coagulate in their interior.[2] Veins may rupture into the connective tissue around the anus, and by subsequent inflammation and condensation of connective tissue give rise to tumors of various size, color, and density, external piles. In general, patients complain of fulness and weight in the rectum, pain in the loins and thighs, bleeding after defecation. Every case should be thoroughly examined before the plan of treatment is settled. Place the patient on the side, on the edge of a sofa, with the knees drawn up; separate the nates gently; external piles will appear as tabs, or bluish more or less inflamed masses covered by skin; internal piles may protrude from the anus as large grape-like tumors, often very sensitive, or, if not protruding, the finger well oiled, introduced into the rectum, will detect the growths.

Fig. 252.



Internal hæmorrhoids.

---

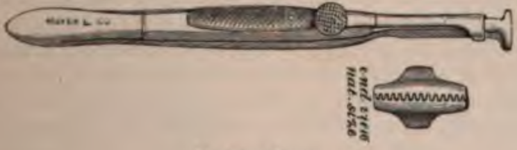
[1] H. Lee.

[2] E. Rindfleisch.

In early stages hæmorrhoids may be cured by the removal of those conditions which cause congestion of the veins of the rectum, and the free use of cold water to the anus when the bowels move. If the piles are inflamed, direct rest in the recumbent position; hot or cold applications, as may be most agreeable; mild cathartics, as the following: mag. sulphate, mag. carb., sulphuris precipitati, sacch. lactis, āā ℥ss; pulv. anisi, ʒij; M.; take one or two tablespoonfuls at bedtime.[1] If external piles suppurate, apply anodyne poultices; when the inflammation subsides use astringents, as lead-water, oint. nutgalls. If internal piles become prolapsed and painful, with fingers well oiled, or with a cloth wet with cold water, reduce them by gentle pressure, the patient reclining with the hips raised, or resting on his knees and elbows.

External piles should be removed by excision; place the patient on the side with the thighs flexed; subdue sensation by local anæsthesia; seize the pile with firm forceps and excise with curved scissors by incisions radiating from the anus. Internal piles may be treated by injections, by the ligature, or by the cautery. The direct injection of carbolic acid is usually very successful, and but slightly painful.[2] Give full dose of castor oil twelve hours before the operation; secure the protrusion of the piles as far as possible by the efforts of the patient, after an enema of warm water, straining over a vessel containing hot water; place the patient on the side and separate widely the buttocks; if the acid is full strength, use two or three drops or dilute it, one part to thirty of olive oil or glycerine, of which six drops may be injected; the tumor becomes white and shrinks; the ligature is employed, after similar preparation, as follows: If an anæsthetic is used, the position with the upper part of the body prone, the hips elevated, and the thighs flexed on the abdomen is preferable, and in this case commence the operation by forcible dilatation of the sphincter ani, by which the interior of the lower part of the rectum is fully exposed.[3] Seize the tumor with forceps; avoid the skin or make a light incision around its base where the covering is integument; transfix with a curved needle armed with a double ligature of stout Chinese silk; divide the ligature at the eye of the needle and tie each half around its portion of the tumor with such firmness as to thoroughly strangulate the base of the part; cut off the ends of the ligature and half of the protruding mass of the tumor, if it is very large; ligate all the hæmorrhoidal tumors in the same manner, and return the mass within the sphincter.

Fig. 253.



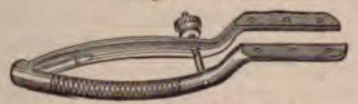
Ligature forceps.

---

[1] G. T. Elliott. [2] R. J. Levis. [3] W. H. Van Buren.

The cautery, galvanic or iron, is preferred by many surgeons; prepare the patient as for ligation; on seizing the pile with forceps apply a clamp (Fig. 254) on its base; the blades of the clamp, the surface of which are faced with ivory to prevent the communication of heat to sensitive parts, close perfectly parallel by means of a screw so as to compress the mass equally; cut off with scissors half of each mass, dry the surface, and apply the cautery at a white heat until the remaining portion is burned to an eschar down to the clamp; remove the clamp carefully, and with well-oiled fingers return the eschars within the sphincter; apply cold to prevent inflammation, and give opiate suppositories or morphine to relieve pain and quiet the bowels; confine the patient to bed with a light diet; at the end of four or five days move the bowels with oil.

Fig. 254.[1]



Clamp for hæmorrhoids.

If the tumor is small, sessile, strawberry-like in appearance, frequently emitting bright red blood, it is composed largely of congested mucous membrane, and may be treated with nitric acid. Prepare the patient as for ligature; while the hæmorrhoid is protruded, wipe the surface with lint, and touch it with the end of a flat piece of wood dipped in nitric acid; smear the parts well with oil, and return the whole within the anus. It is not necessary to confine the patient to bed; if hemorrhage occur, examine the part, and apply a styptic to the bleeding surface.

The urethral veins of the female become varicose, and appear as small vascular tumors of the meatus urinarius;[2] they may be single or multiple, pedunculated or sessile; their most frequent site is the floor of the meatus at its extremity, but they may extend deeply. The more marked symptoms are proneness to bleed, great sensitiveness, liability to become extruded and inflamed, pain during micturition. An examination, which should always be made when the patient complains of pain in urination with occasional bleeding, reveals the nature of the disease. The ligature and caustic are the only effective agents. Apply a twenty per cent. solution of muriate of cocaine fifteen minutes before the operation; place the patient in the position for lithotomy; if the ligature is used, transfix the mass from behind forwards with a fine tenaculum, and apply the thread beneath the instrument so as to inclose the base of the tumor; if caustic is preferred, it must be boldly used; the actual cautery, especially the galvanic, is most manageable. Chromic acid may be used as follows: Surround the growths with cotton-wool soaked in solution of carbonate of soda; make a swab of cotton-wool on a stick, with which apply the acid solution; repeat in five or six days.[3]

The spermatic veins, when varicose, constitute varicocele; these veins are subject to turgescence, the chief factor in its production being ungratified sexual desire, or abuse of the sexual organs, by which the veins are kept constantly engorged;[4] dilatation, serious enough to constitute a disease, is an exaggeration of this condition; it occurs in early manhood, on the left side, rarely on the right; the vessels are elongated, the valves broken down, and the walls thickened and affected with fatty atrophy; the mass fills up one side of the scrotum, is of a pyriform shape, and has the feeling of a bunch of earth worms; in the recumbent position the tumor disappears, proving that it is not hydrocele, and if a finger is pressed on the external ring, when the patient rises, the tumor will return, showing that it is not hernia. The slighter grades are cured by the removal of the conditions inducing congestion of the veins, and the free use of cold water; the severe forms may be palliated by the use of the suspension apparatus, and a compress or truss so placed over the external ring as to prevent the distension of the veins by exertion.

---

[1] H. Smith.

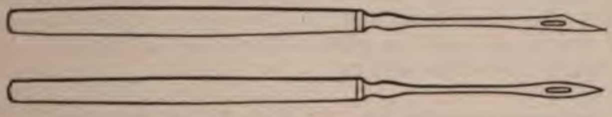
[2] J. Hutchinson.

[3] A. W. Ellis.

[4] Van Buren and Keyes.

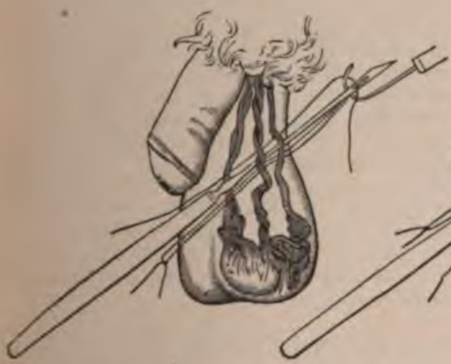
Operations for the radical cure of varicocele have been simplified and rendered so safe by antiseptics that old methods should be discarded. The following operation[1] is easily performed, is almost absolutely safe, and results in cure: Select two needles (Fig. 255); carbolized catgut one-half millimetre in diameter; thread the needles to be used with a loop of silk and a piece of carbolized catgut, and place it in carbolic acid solution. Wash the scrotum with soap and water, shave the parts, and cleanse the surface with bichloride solution. Inject a few drops of a four per cent. solution of cocaine near the point of proposed puncture. Ether should not be used as the

Fig. 255.



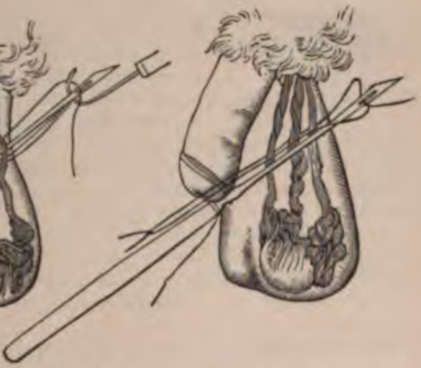
Straight needles in handles.

Fig. 256.



First position of needle, showing loop, catgut, and tenaculum.

Fig. 257.



Showing second position of needle, with catgut passed through loop.

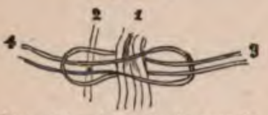
---

[1] E. L. Keyes.

patient must stand. The patient standing near the bed in a good light, separate the spermatic cord from the veins in the usual manner, high up where the dilated trunks may be made out as straight channels; pinch the scrotal tissues tightly, between the cord and the veins, with the thumb and finger of the left hand. Now thrust the needle through the scrotal tissues from before backward at the point pinched, leaving the veins on the outer side of the needle towards the thigh (Fig. 256). When the eye of the needle emerges at the back of the scrotum, seize with a tenaculum the catgut ligature, and pull it out of the eye of the needle; withdraw the needle into the scrotum, leaving the end of the catgut thread hanging from the posterior wound, and allow the veins to return to the cord; without removing the point from the anterior puncture pass the needle, charged with its loop of silk, on the outside of the veins and under the skin, accurately through the posterior puncture (Fig 257); with the tenaculum loosen the loop of silk and draw through it the free end of the catgut which was left at the first puncture protruding posteriorly; irrigate the parts with the bichloride solution, and then withdraw rapidly the needle with the loop containing the catgut; tie the catgut into a triple knot, cut it short, and apply adhesive plaster if the punctures bleed. Iodoform may be dusted over the surface.

Other methods are as follows: (*a*) With the left thumb and index finger separate the vas deferens, which feels hard and cordlike from the veins; carry a needle armed with a double ligature behind the veins and leave it in place; now drop the veins and grasp only the skin and through the same orifices, but in the reverse direction, carry a second loop in front of the veins; the bundle of veins (Fig. 258) is included between the two loops; pass the free extremities of each thread through the loops of the other, and tighten them (Fig. 258), thus effectually strangulating the veins under the skin; fasten the extremities by tying over a small roll or compress[1] Subcutaneous section may be performed as follows:[2] (*b*) Pass a needle between the vas deferens and the veins at two points, separated one inch, apply a ligature over each needle sufficiently firm to stop all circulation in the veins; two days after divide subcutaneously the veins, which feel like soft cords between the two pins; two days later withdraw the pins; within the next three or four days the cure will be complete by the consolidation of the veins. (*c*) Excision of the scrotum is practised thus: Place the patient in the recumbent position, the testis being raised to the external ring by an assistant; draw a sufficient portion of the relaxed scrotum between the fingers; excise with the knife or large scissors and tie all bleeding arteries; bring the edges of the incised skin together by raising the lower portion towards the upper, and apply the requisite number of sutures; use antiseptic dressings.[3]

Fig. 258.



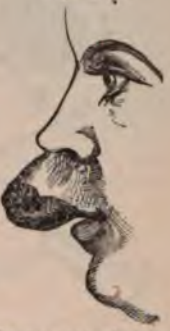
Loop around spermatic vessels.

Venous nævi, cavernous angiomata,[4] consist chiefly of distended veins, in a white, firm, tough network, having an indistinct boundary; or a sort of capsule; these tumors are rarely congenital, but generally appear in childhood or youth; their seat is chiefly in the subcutaneous cellular tissue, more frequently in the face; they often occur in large numbers, but in such a way that a certain vascular district is to be regarded as the seat of disease, as the face, arm, foot, or leg; they cause weakness of muscles, some pain, and disfigurement; they may attain considerable size and prove dangerous, especially by their destruction of bone; they are recognized by fluctuation, want of pulsation, compressibility, and swelling on forced expiration. The tumor must be destroyed by (1) excision, when the growth is large, the line of incision being quite external to the capsule; (2) injection of persulphate of iron, in small quantities, when the tumor is small, and not amenable to other remedies, as on the face, great care being taken to compress the vessels around the tumor to prevent the escape of the fluid into the general circulation. Nævi of the lips (Fig. 259)[1] require different treatment according to the amount of substance involved; when pendulous from the margin the double or quadruple ligature may be used; if the whole thickness is involved galvano-puncture weekly is safest; if the whole lip is diseased the stronger caustics may be required, such as nitric acid or potassa cum calce, the bleeding being arrested by pressure.

---

[1] M. Ricord. [2] H. Lee. [3] Sir A. Cooper. [4] T. Billroth.

Fig. 259.



Large nævus of upper lip; side view.

IV. THE CAPILLARIES.

The capillaries may form vascular or erectile tumors, consisting almost exclusively of vessels held together by connective tissues.

The plexiform angioma, telangiectasis, cutaneous nævus, is composed entirely of dilated and tortuous capillaries and anastomosing vessels, and occurs almost exclusively in the cutis; they may be of a dark cherry, or a steel-blue color, according as the superficial or deep-seated vessels of the cutis are involved; they are sometimes as large as a pin's head, and again as a hempseed; some are moderately thick, others scarcely rise above the level of the skin; as a rule, this proliferation of vessels does not extend beyond the subcutaneous cellular tissue, their growth is always slow and painless;[2] they frequently not only cease to enlarge, but undergo a gradual contraction and obliteration; hence the propriety of treating them at first with mild remedies, as pressure, applications of collodion, vaccination. If more radical measures become necessary, inject persulphate of iron, using precautions by pressure around the growth to prevent the entrance of coagula into the circulation; or pass red-hot needles under it at several points and secure a slough. Strangulation of the mass by subcutaneous ligature, when the growth is accessible, is adapted to the larger nævi, and may be applied in many ways, as follows: (1) The single ligature; strong whip cord (Fig. 260)[3] is carried around the tumor by entering it at one point and carrying it as far as possible round the base, then emerging and reëntering at the same puncture and is carried around another portion, until it reaches the point

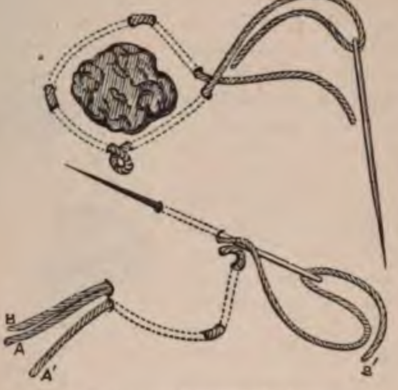
---

[1] J. E. Erichsen.

[2] T. Billroth.

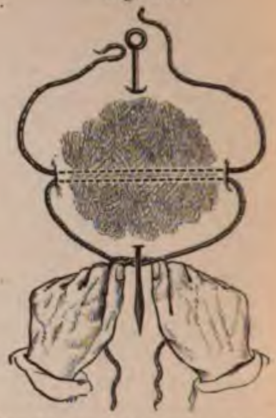
[3] T. Holmes.

Fig. 260.



Subcutaneous ligature of nævus.

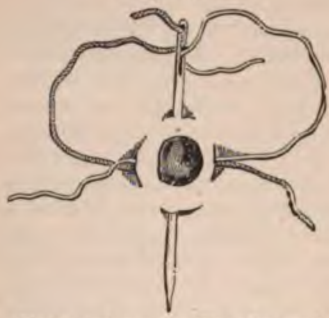
Fig. 261.



Ligature of a mixed nævus. A pin is passed through the growth and a needle at right angle to the pin is armed with a double ligature.

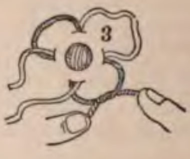
of first entrance, where the two ends are firmly tied; (2) or, if the growth is too large, the ligature may be carried, double, under the tumor, and then each section may be carried round the half and tied under a pin (Fig. 261).[1] For a large nævus the following knot may be made: Pass the needle under the centre of the tumor (Fig. 262),[2] divide one thread near the needle; pass the other end of the ligature into the needle's eye; now enter the needle at a quarter of the circumference and pass it under the base at right angles to its former direction; before tying the ends make a lunated incision between each puncture into which the ligature sinks; finally, tie the opposed ends (Fig. 263).

Fig. 262.



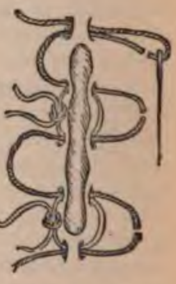
Ligature of nævus. The other end of the divided thread passed into the needle's eye, and the needle passed through at right angles to its former direction.

Fig. 263.



Incisions for ligature.

Fig. 264.



An elongated nævus.

---

[1] T. Bryant.

[2] Sir W. Fergusson.

If the tumor is elongated in form, the ligature may be applied as follows (Fig. 264): Pass a double ligature under its base from side to side; color the end of one ligature white and the other black; leave each loop long, the whole ligature being of great length; divide the white loops on one side and the black on the other, and tie the pairs of white and black strings tightly; the skin is destroyed by this method.[1]

The elastic ligature has been successfully used thus:[2] Select straight needles without cutting edges, threaded with common band elastic of pure gum rubber, and pass subcutaneously beneath one side of the growth in succession, each successive needle with its ligature entering at the point of exit of the last one.

CHAPTER XXVI.

GENERAL OPERATIONS ON THE CIRCULATORY SYSTEM.

I. THE HEART.

The only general operation on the heart and pericardium is undertaken for the relief of dropsy. In order to perform any operation upon this organ it is important to be able to define its normal position.

That part of the heart which lies immediately behind the wall of the chest, and is not covered by lung, is sufficiently defined for all practical purposes by a circle two inches in diameter round a point midway between the nipple and the end of sternum; the apex pulsates between the fifth and sixth ribs, two inches below the nipple, and one inch to its sternal side, this point varying slightly with the position of the body, and with inspiration and expiration.

Paracentesis of the pericardium is practised as follows: The most prominent point being carefully determined, select the left fifth intercostal space from two-fifths of an inch to two inches from the sternum, according to the prominence of the sac; make an incision a little more than an inch long parallel to the ribs in the centre of the space commencing about two-fifths of an inch to the left of the sternum; carefully divide the layers of muscle until an elastic dilatation is felt which resists under pressure with an indistinct impulse of the apex of the heart; make a slight puncture and introduce a small trocar or the aspirating needle.

The statistics[3] show that in 97 cases of paracentesis 38 were successful. The operation is therefore justifiable in cases where life is imperilled by the copiousness of the effusion, and even if the pericarditis be not in itself dangerous, if there is considerable pericardial effusion, and the pulse threatens to fail, the operation should be tried. Pericardiac paracentesis by free incision after resection of rib[4] has been successfully performed for purulent pericarditis. The fifth rib was resected and the pericardium extensively incised; pus flowed freely; pericardium was fixed with catgut sutures to the edges of the cutaneous wound, and the serous membrane washed with a thymic acid solution; heart could be felt just under the finger; a small fistula remained. In a second case[1] patient suffered for years from cardiac palpitation; fell from a considerable height and was unconscious for a day; recovering consciousness suffered from giddiness and intense palpitation on slightest exertion; increased area of dulness over region of the heart, with feeble but normal heart sounds; dyspnœa, cyanosis of lips and nose; steadily grew worse; at end of third week aspiration with Dieulafoy's apparatus was performed in fourth intercostal space; eighty cubic centimetres of the fluid drawn off, consisted of pure cream-like pus, and forty cubic centimetres of pure blood; immediately after the puncture patient was in a state of semi-collapse, but a slight improvement followed in the subjective symptoms; on the day following, the cardiac dulness reached up as far as the clavicle, pulse became scarcely perceptible, dyspnœa extreme, and mucus rales in the lungs; to satisfy the vital indication incision of the pericardium was performed about two centimetres in length, close to the left edge of the sternum, in the fourth intercostal space; about two fluid pounds of blood escaped; washed out the pericardial cavity with boracic water (38° C.), inserted drainage-tube, and applied carbolic gauze; striking relief immediately followed, dyspnœa diminished; pulse became regular and 90, cardiac dulness normal; in spite of three successive subcutaneous injections of ethereal tincture of valerian, the cardiac action remained low, and patient died eighteen hours after the operation.

---

[1] T. Holmes.

[2] G. R. Fowler.

[3] T. J. Stewart.

[4] C. Gussenbauer.

II. THE ARTERIES.

The general operations upon the arteries are arteriotomy and ligation.

The arteries possess considerable strength and a high degree of elasticity, being both extensible and retractile in width and length; they are inclosed in a sheath of connective tissue, and have three independent coats, namely, internal, middle, and external; the internal coat consists of epithelium and elastic tissue; the middle of muscular fibres disposed circularly round the vessel, and the external of elastic and connective tissue; arteries are accompaned by one or more veins, and nerves.

ARTERIOTOMY.

Arteriotomy, very rarely practised, is performed to secure sudden loss of blood and thus make a profound impression on the system or relieve sudden congestion. The temporal artery is preferred, and the anterior branch selected. Incise its coats obliquely with a sharp-pointed lancet or bistoury, and when sufficient blood has flowed, divide it completely, and apply a compress and bandage.

LIGATION OF ARTERIES.

The application of a ligature to an artery can now scarcely be considered a serious operation, for when the antiseptic method is pursued suppuration does not occur, and if the proper kind of ligature is used division of the artery does not follow, and hence there is no danger of secondary hemorrhage. It is now established that when an artery is closed by an aseptic ligature it is not necessary to divide the internal coat, but only to press its opposing surfaces together temporarily to secure permanent obliteration of its canal. In this process the intima becomes covered with granulations; these unite and form a firm union; also new tissue forms around the ligature, like a ring of callus, strengthening the point of ligation; meantime the ligature undergoes absorption, and the cure is complete. By the antiseptic operation the artery is strengthened at the seat of ligature, and there can be no danger of hemorrhage. It should, however, be borne in mind that to secure the best results the ligature must be of an absorbable nature; for ligatures which permanently resist absorption destroy the continuity of the vessel, and instead of adding strength to the paravascular cicatrix, weaken the vessel walls at the seat of ligation.[1] The general rules to be observed in ligating an artery may be thus given:—

---

[1] E. A. Mikhailova.

The point of application of the ligature (Fig. 265)[2] when applied for aneurism, depends upon the situation and condition of the aneurism. It should be applied (1) on the cardiac side at a distance from the tumor, when the artery can be tied with comparative ease and safety, as the femoral for popliteal aneurism; (2) on the cardiac side, near the tumor, when the space between the tumor and important parts on the proximal side is slight, and the artery in this space is sound, as the external iliac for aneurism of the femoral near Poupart's ligament; (3) on the distal side, when the proximal ligature is impossible, as the axillary for subclavian aneurism; (4) on a distal branch, when the cardiac and distal ligature of the main trunk is impracticable, as on the subclavian for innominate aneurism; (5) at the aneurism, the old operation, when the tumor is so situated that it is inadmissible or impracticable to ligate the trunk on the cardiac or distal side.

Fig. 265.

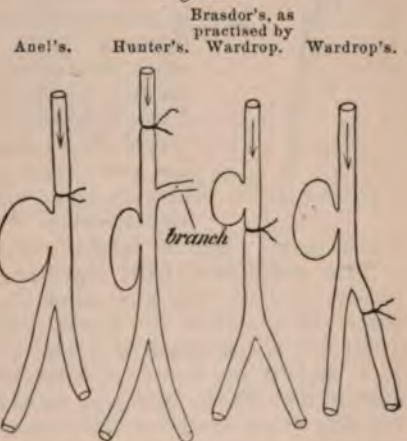


Diagram showing the different operations for aneurism.

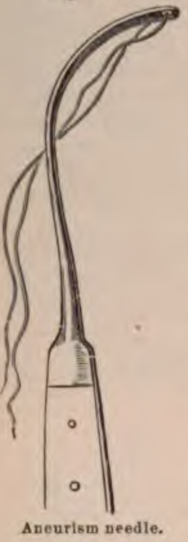
The instruments required are a scalpel, forceps, aneurismal needle, ligature, director, and spatulas. The common scalpel is best adapted to the dissection, and the broad extremity of the handle can be used to advantange in separating layers of fascia, and parts where the cutting edge is not desirable; the dissecting forceps should have accurately fitting teeth, and not liable to open at the extremity when firmly closed; a pair of small forceps may also be required. The aneurism needle is a curved blunt instrument, with an eye near the extremity, and firmly fixed in a handle (Fig. 266). When used, the extremity is gently insinuated under the vessel, and as it appears upon the opposite side, the loop of the ligature is seized with the forceps, or a hook, and one end being drawn through, it is held as the instrument is withdrawn carrying the other end, and thus leaving the ligature under the vessel. A needle well adapted to those cases where the artery lies deeply consists of the handle and hook (Fig. 268), and the blunt needle with two eyes (Fig. 267); the needle is fitted to the shaft (Fig. 268) by a screw; when used, the ligature is inserted into the second eye; the needle is then passed under the artery, and as the extremity emerges upon the opposite side, the hook is inserted into the first eye, and the needle is thus held until the handle is unscrewed, when it is drawn through with the ligature. It is sometimes necessary to include other tissues with the artery, when the sharp pointed needle (Fig. 267) should be used. The director is used in the dissection to raise the fascia before its division; it is sometimes passed under the artery as a guide to the needle. Two retractors are often required, with which assistants separate the sides of the wound, and expose the deep-seated parts; pieces of flexible metal or wood may be used.

---

[1] M. Senn.

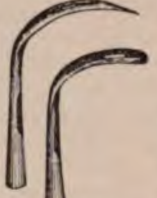
[2] T. Bryant.

Fig. 266.



Aneurism needle.

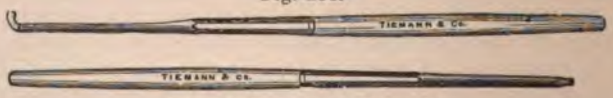
Fig. 267.



Needles for deep ligations.

The aseptic catgut ligature more effectually meets the indications present than any other kind. When so applied as not to sever the tunics of the ligated vessel it is gradually displaced by organized tissue which increases the resisting capacity of the vessel.[1] It is stated[2] that the most careful microscopical examinations have shown that catgut increases to a considerable extent the resisting capacity of an artery in forming firm connective-tissue connections with the vessel. It follows that catgut ligature should be preferred, and that it is only necessary to tie with sufficient force to approximate the inner surfaces of the intima with a view to insure effective provisional obliteration when cicatrization will follow.[1]

Fig. 268.



Artery hook and handle for needle.

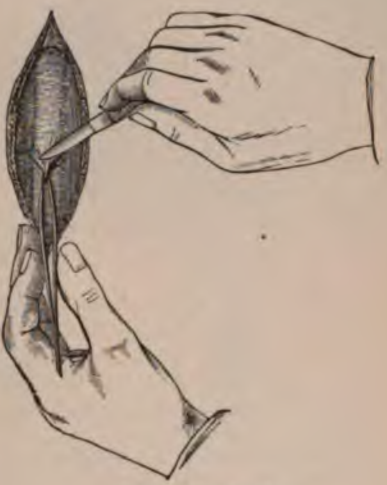
The operation must be conducted with all the antiseptic measures scrupulously attended to throughout; the anæsthetic administered, the surgeon takes his position generally on the outside of the limb which is the seat of the operation; a second assistant takes a position where he can command the artery above if by any accident it is wounded, or if the artery yields under the tightened ligature; a third uses the irrigator, and a fourth separates the wound with the spatulas. Determine the precise location of the artery. (1) By its pulsations; (2) by given anatomical points in the vicinity. To render the former distinct, the limb should be placed in a position favorable to arterial circulation; to render muscles and tendons most distinct the limb should be forcibly extended at the commencement of the operation. When the dissection has proceeded so far as to reach the vicinity of the artery, the operator is aided in detecting its position by flexing the limb so as to relax the muscles and tissues. Before the first incision is made guard against wounding superficial veins. Their position is readily defined by compressing the parts above the point of the proposed operation. When the first incision is about to be made, the skin should be rendered tense by the thumb and forefinger of the left hand applied, one on either side of the vessel; or the fingers applied at the extremity of the proposed incision, parallel to its course; if the first method is chosen, care must be taken not to make more traction on one side than on the other. The second method answers where the skin is naturally tense and but slight traction is necessary. Hold the scalpel in the second or third position (Figs. 42, 43); make the incision directly over and parallel to the artery, through the skin only if the artery is superficial, but also through the cellular tissues if it is deep, its length varying with the depth of the vessel and the adipose tissue.

---

[1] M. Senn.

[2] Nussbaum.

Fig. 269.



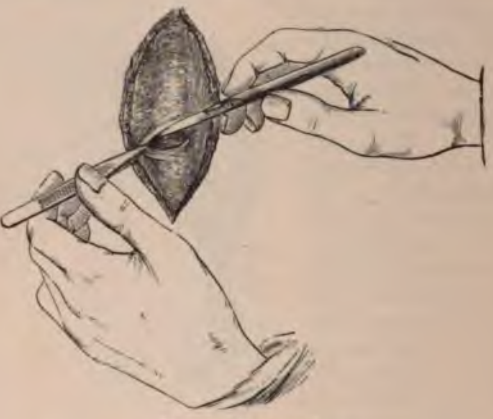
Opening the sheath.

The incision is sometimes made in the direction of the fibres of the muscle covering the artery, as where the great pectoral overlies the axillary; at other times it should be curved, so as to raise a flap.

The length of the incision cannot be prescribed, but it should always be ample. Pinch up the fascia carefully with the forceps (Fig. 269), nick it with the scalpel applied horizontally; incise freely on a director introduced beneath. In dissecting among muscular structures enter the muscular interstices, and do not wound the substance.

These inter-muscular spaces are marked by deposits of fat, especially towards the terminal extremity of the muscles, and hence we should commence the separation of muscles as nearly as possible at their terminal extremity. If there is doubt as to the line of separation, a puncture will disclose adipose or muscular tissue, according to the nature of the underlying structure. If the dissection is made through the body of the muscle, the fibres separate more readily in an inverse direction, namely, from their origin to their attachments. The muscles may be separated with the handle of the scalpel or the finger nail.

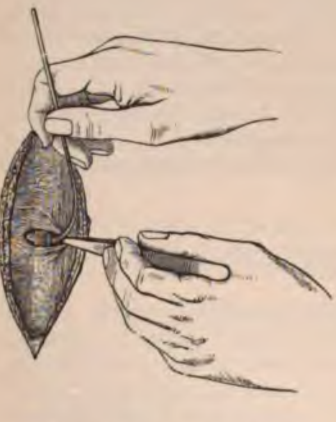
Fig. 270.



Cleaning the artery.

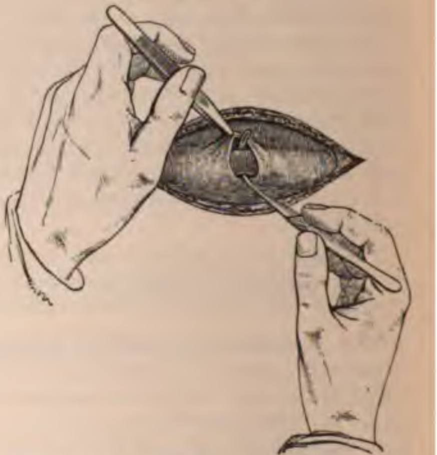
The larger arteries have firm sheaths, which require to be opened by dissection (Fig. 270); the smaller vessels have but slight investments, and are readily exposed with the point of a director, or the aneurism needle. The sheath opens by pinching up a small portion with the

Fig. 271.



Passing the needle; first stage.

Fig. 272.

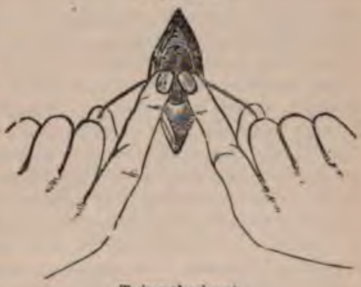


Passing the needle; second stage.

forceps, and nicking it slightly with the scalpel; into the opening thus made, introduce the point of the needle (Fig. 271); by slight movements of its point, first upon one side and then upon the other, separate the sheath completely around the vessel, to an extent sufficient to allow simply the passage of the ligature; as the extremity of the instrument emerges on the opposite side, with the finger of the left hand, or the thumb and forefinger pressed together, steady its point as it penetrates the last portion of the sheath. If the artery is small and very superficial, a director may be passed under, and along its groove, a blunt needle carrying the ligature. If more deeply situated, the common aneurism needle (Fig. 266), or the double-eye needle (Fig. 267), should be used. The point of the needle gently moved laterally, aids materially in separating the artery from the sheath (Fig. 272). The needle should be passed from the veins; no force should be used, lest the instrument penetrate the coats of the artery.

The ligature should be placed at right angle with the long axis of a vessel, and the reef-knot (Fig. 12) tied, unless there are special reasons for adopting the surgeon's knot (Fig. 11). The first knot is tightened around the vessels firmly, on either side of the ligature, near the artery, with the index fingers carried to the bottom of the wound (Fig. 273). The degree of constriction varies with the size of the arteries, but it need not be so great as to rupture the internal coats. In tying the second knot care must be taken not to tighten the thread firmly until traction is made on a plane with the first knot, with the fingers again carried down to the vessel. The two ends of the ligature must be cut off near the knot.

Fig. 273.



Tying the knot.

The dressing of the wound should be strictly antiseptic, for the purpose of securing immediate union. The irrigation with bichloride solution should be thorough and continued until the wound is closed. A catgut drain should be placed in the lowest angle; the deeper structures may first be stitched with the continuous catgut suture; then, if the wound is large, two or three deep sutures of relaxtion may be inserted; approximate the cutaneous wound with the continuous or interrupted silkworm-gut suture. Complete the dressing by cleaning the external surface, dusting it with iodoform, and applying the iodoform gauze, or a bandage of bichloride gauze. The wound should not be dressed for a period of twelve to fourteen days, unless there are indications of disturbance.

The following conclusions[1] are important, and may be regarded as embodying the principles which should now govern in the ligation of arteries and veins: 1. All operations on bloodvessels should be done under antiseptic precautions;

---

[1] M. Senn.

2. The aseptic catgut ligature is the safest and most reliable agent in securing provisional and definitive closure of bloodvessels; 3. A thrombus after ligature is an accidental formation which never undergoes organization, and takes no active part in the obliteration of a vessel; 4. The intravascular or definitive cicatrix is the exclusive product of connective tissue, and endothelial proliferation; 5. Permanent obliteration in arteries takes place in from four to seven days, and in veins from three to four days; 6. In ligating vessels in aseptic wounds the vessel sheath can be opened freely without compromising the integrity of the vessel tunics, and such procedure renders the operation safer and easier of execution; 7. The double aseptic catgut ligature should be preferred to the single ligature in ligating large arteries in their continuity near a collateral branch, and should always be employed in all operations of tying varicose veins in their continuity as the safest and most effective measure in producing definitive obliteration.

ARTERIES OF THE THORAX, NECK, AND HEAD.

The general rules concerning the management of aneurisms and the ligation of arteries, for their cure, in this region, are as follows:[1]—

Aneurism of the arch of the aorta is best treated by rest, unstimulating diet, sedatives, and iodide of potassium; the ligature is justifiable only when the aneurism is believed to implicate the transverse portion of the arch and be extending along the course of the carotid into the neck, in which case the corresponding artery, generally the left, may be tied. In innominate aneurism, when medical treatment has failed, the tumor extends, especially along the trachea, as will be proved by its growth and the increasing dyspnœa, it is justifiable to tie the right carotid, and perhaps also the subclavian artery. Aneurism of the common carotid low down in the neck may be treated with good prospect of success by the distal ligature.[1] Aneurism near the bifurcation, or in one of the secondary carotids, or their branches, may be treated by compression of the common carotid at the anterior tubercle of the fifth cervical vertebræ; if this fail or is impracticable, and the artery is easily accessible, apply a ligature to the trunk. In extreme cases an aneurism may form in the carotid which, from its position and extent, does not admit of the proximal ligature, and from its condition does not warrant the distal ligature; in such a case the operation of laying open the sac and tying the artery at its entrance to the tumor has been recommended[2] as follows: The patient being under an anæsthetic, with shoulders slightly elevated, pass the knife into the most prominent part of the tumor, and follow the blade with the forefinger of the left hand so closely as to prevent the effusion of blood; search with the end of this finger for the opening in the artery, and when found, which may be known by a cessation of pulsation, press firmly; now lay the cavity freely open, turn out the clots, sponge away the blood, and expose and ligate the artery first on the cardiac, and then on the distal side.

The innominate arises from the right superior portion of the arch of the aorta, in front of the left carotid, and passes in an oblique direction, upwards, outwards, and backwards to the superior margin of the sternal articulation of the clavicle, where it divides into the right subclavian and right common carotid, being from one and a half to two inches in length.

It is in relation on the right with the pleura, right vena innominata, and right pneumogastric nerve; behind, with the trachea; on the left with the left carotid; in front, above, with the sternum, and the origin of the sterno-hyoid, and thyroid, below, with the inferior thyroid vein and left vena innominata.

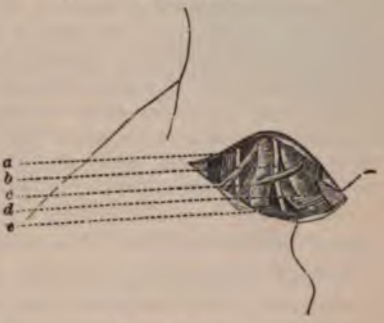
---

[1] T. Holmes.

[2] J. Syme.

Place the patient on the back, with the shoulders slightly raised, the right arm drawn downwards, and face turned to the opposite side; make an incision three inches in length, just above the clavicle, terminating over the trachea, and, if required, a second of the same length, from this point along the inner border of the sterno-mastoid; divide the sternal and part of the clavicular portion of the sterno-mastoid, *e*, on a director and turn outwards; divide the sterno-hyoid and thyroid in the same manner; draw them inwards, exposing the sheath of the carotid, par vagum, and internal jugular vein; now separate the par vagum, *b*, from the carotid; draw the vein, *c*, to the outside, and the artery towards the trachea, and expose the subclavian; the innominate artery, *d*, is now uncovered; pass the needle from below upwards and inwards; care is necessary to avoid wounding the pleura behind.

Fig. 274.



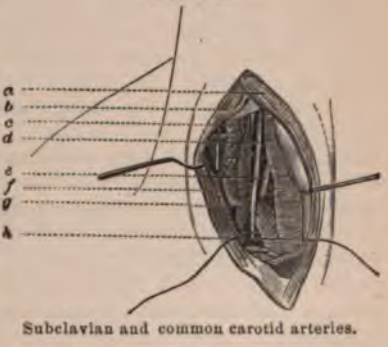
Innominate artery.

Or, make an incision three inches in length, extending from a point midway between the two sterno-mastoid muscles, towards the right shoulder, half an inch above the clavicle (Fig. 274); incise the skin and platysma; then, on a director, divide the sterno-mastoid, *e*, and sterno-hyoid and thyroid successively; with the handle of the knife the artery, *d*, is isolated, care being taken to avoid the pneumogastric nerve, *b*, the internal jugular vein, *c*, and the phrenic nerve, *a*.

Compression of the innominate has been suggested[1] by making a central cervical incision, as in low tracheotomy, and inserting the finger behind the artery and compressing it against the sternum.

The subclavian and common carotid arteries (Fig. 275) may be ligated by the following operation: Place the patient in the position for ligature of the innominate; make an incision three inches in length through the integuments, along the space separating the clavicular and sternal attachments of the sterno-cleido-mastoid muscle; this interval is marked by a depression above the clavicle, at the articulation of the clavicle and sternum; flex the head; slightly separate the internal portion of the muscle, *a*, from the external, *b*; divide the sterno-hyoid and thyroid on the director; the innominate,

Fig. 275.



Subclavian and common carotid arteries.

---

[1] T. Annandale.

h; the common carotid, *e*; the pneumogastric, *d*, and its branch, the recurrent laryngeal; the origin of the subclavian, *g*, and its branches, the vertebral, *c*, and inferior thyroid, are now under control.

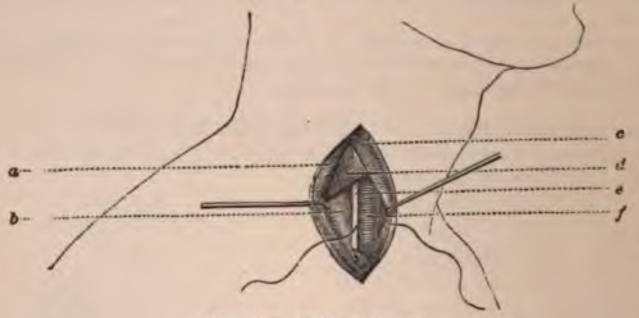
The common carotid arteries extend on the right side from the innominate, and on the left from the highest point of the arch of the aorta, to the upper border of the thyroid cartilage; the direction is obliquely from before backwards, and from within outwards, along the external side of the trachea and larynx, in a line drawn from the sternal end of the clavicle, below, to a point midway between the mastoid process and angle of the jaw above. The sheath is derived from the deep fascia, and contains the internal jugular vein and the pneumogastric nerve, the vein being external, and the nerve between.

(*a*) At the base of the neck the artery is deeply seated, and a ligature should be applied at this point only from necessity.

In front is the platysma, superficial and deep fasciæ, the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles; externally it is in relation with the pneumogastric nerve and internal jugular vein; internally with the trachea; posteriorly with the longus colli and rectus anticus major muscle; the internal jugular of the right side recedes from the artery, but on the left approaches and often overlaps it. The carotid tubercle is a guide to the position of the artery;[1] this tubercle is the anterior projection of the tranverse process of the sixth cervical vertebra, which is two inches above the clavicle, and is a precise guide to the artery when the neck is straight; it corresponds in front and a little inside to the artery.

Operation (Fig. 276).[2]—The patient in the recumbent position, the head extended and inclined to the opposite side; recognize the interval between the two attachments of the sterno-mastoid muscle, and make an incision from the clavicle, two and a half inches, obliquely, along this interspace; divide the skin, platysma, and deep fascia; draw the internal portion of the muscle, *c*, inwards, and the external, *a*, outwards, by means of spatulas; this exposes the internal jugular vein, *b*, and the pneumogastric nerve, *e*, lying between the vein, *b*, and the artery, *f*, and the omo-hyoid muscle, *d*, crossing the

Fig. 276.



Common carotid; first part.

---

[1] Chassaignac.

[2] Sédillot.

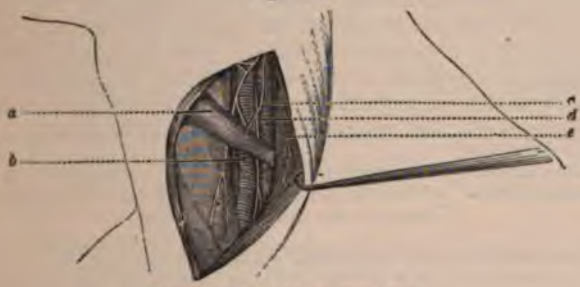
upper part of the wound; open the sheath and pass the needle from without inwards, carefully avoiding the internal jugular vein and par vagum; a finger pressed upon the vein at the upper part of the wound will cause it to collapse.

(*b*) Below the omo-hyoid the artery is much more accessible.

It is covered by the integument, the platysma, the superficial and deep fasciæ, the sternal part of the sterno-mastoid, the sterno-hyoid and thyroid muscles; it is crossed obliquely, from within outwards, by the sterno-mastoid artery, also by the superior and middle thyroid veins, and lower down by the anterior jugular; on the outer side are the pneumogastric nerve and internal jugular vein, and on the inside are the inferior thyroid artery and recurrent laryngeal nerve, which separate it from the trachea and thyroid gland; the descendens noni nerve lies on the sheath of the artery.

Operation (Fig. 277).—Place the patient on the back, with the head thrown back; make an incision three inches in length along the inner border of the sterno-mastoid muscle, in the line above given, terminating at the top of the sternum; successively divide the skin, superficial fascia, platysma, and deep fascia, and expose the inner border of the sterno-mastoid, *e*; carefully avoid the sterno-mastoid artery and middle thyroid vein; throw the head forward and draw the sterno-mastoid muscle outward, and the sterno-hyoid and thyroid muscles inwards; expose the anterior belly of the omo-hyoid muscle, *a*, which should be drawn upwards; divide the deep fascia; expose the sheath of the vessel; open it directly over the artery, avoiding carefully the descendens noni, which runs along the tracheal side; press the pneumogastric nerve, *d*, and internal jugular vein, *c*, outward, and pass the needle from without inwards, carefully isolating the vessel from the inferior thyroid artery, and recurrent laryngeal nerve which lies behind it.

Fig. 277.



Common carotid below omo-hyoid.

The thyroid body may be so large as to mislead as to the margin of the muscle, and then requires careful dissection; if the omo-hyoid muscle interferes with the operation it may be turned aside, or even divided by dissection.

(*c*) Above the omo-hyoid the artery is still more superficial, being covered only by the skin, the two fasciæ, platysma, and the border

Fig. 278.

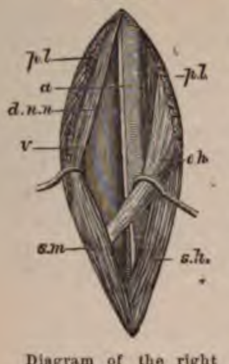


Diagram of the right common carotid artery at the seat of ligature. *pl.* platysma; *s. m.* sterno-mastoid, drawn to cone side; *o. h.* omo-hyoid, drawn downwards and inwards; *s. h.* sterno-hyoid; *a.* the artery; *v.* internal jugular vein; *d. n. n.* descendens noni nerve. The pneumogastric is not seen, as it lies behind the vessels.

of the sterno-mastoid; it is in relation internally with the larynx and pharynx, and externally with the pneumogastric nerve and internal jugular vein (Fig. 278).

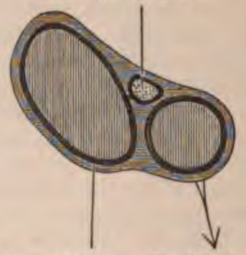
Operation.—Place the patient on the back, the shoulders raised, and the head turned to the opposite side; make an incision from a little below the angle of the jaw, in the line given, along the internal border of the sterno-mastoid, three inches in length; divide the integuments, superficial fascia, and platysma; raise the deep fascia carefully on a director; avoid the small underlying veins; flex the head to relax the muscles, and draw the wound apart by spatulæ; avoid the descendens noni nerve and superior thyroid arteries, and open the sheath over the artery; if the internal jugular vein swell up into the wound, compress it in the upper and lower part of the wound, and draw it outwards; pass the ligature from without inwards, the point of the needle being kept close upon the artery, to avoid wounding the vein or including the pneumogastric nerve (Fig. 279).

Ligation of the carotid above the omo-hyoid is easiest of execution and should be preferred when the surgeon can elect the point of operation.

The external and internal carotids arise from the common trunk at the upper border of the thyroid cartilage, the external being more superficial and internal at their origins.

Fig. 279.

Pneumogastric nerve.



Jugular vein; venous compartment of sheath, the part to be avoided.

Carotid artery, showing arterial compartment of sheath. An arrow indicates the part to be opened.

Diagram of the carotid sheath.[1]

They occupy the triangle formed by the sterno-mastoid behind, the omo-hyoid below, and the posterior belly of the digastric and stylo-hyoid above; and are crossed by the hypo-glossal nerve, and the lingual and facial veins.

[1] Sir W. MacCormac.

Operation.—Make an incision along the inner margin of the sterno-mastoid, three inches in length, from the angle of the jaw to the cricoid cartilage, through the skin, platysma, superficial and deep fascia; the internal margin of the sterno-mastoid now appears; cautiously separate the cellular tissue, and the wound being drawn apart, the external carotid artery is exposed; draw the digastric muscle and hypoglossal nerve upwards, and the internal jugular outwards; both arteries may now be ligated or either artery separately.

The external carotid artery ascends from its origin at first, slightly forwards, then backwards, to the space between the condyle of the lower jaw and the meatus auditorius; above the digastric the artery lies more deeply and is crossed by the stylo-hyoid muscle.

The common carotid should never be tied for a lesion of the external carotid or its branches when there is room between the lesion and bifurcation of the primitive carotid to permit the ligature of the external carotid.[1]

Operation.—Make an incision from the lobe of the ear to the great cornu of the hyoid bone, along the inner margin of the sterno-mastoid about three inches; divide the skin, platysma, and fascia; separate the posterior belly of the digastric and stylo-hyoid from the parotid gland, by depressing the muscles, and the artery will be exposed.

The ligature may be applied between the origin of the superior thyroid and lingual arteries where there is often an interval of three-fourths of an inch, or at a higher point, but there is rarely space between the bifurcation and the superior thyroid.

The superior thyroid artery arises from the external carotid, just below the greater cornu of the hyoid bone, and passes inwards to the thyroid gland in a tortuous course; it is at first superficial, lying in the triangle formed by the sterno-mastoid, digastric, and omo-hyoid muscles.

Operation.—Place the head in an extended position; make an incision an inch and a half along the internal border of the sterno-mastoid, the centre of which corresponds to the great cornu of the thyroid cartilage; incise the skin and platysma; draw the sterno-mastoid outwards and expose the omo-hyoid muscle, internal jugular vein, and primitive carotid artery; the artery lies between these vessels and the lobe of the thyroid body, pass the needle from above downwards with the point inclined to the thyroid body.

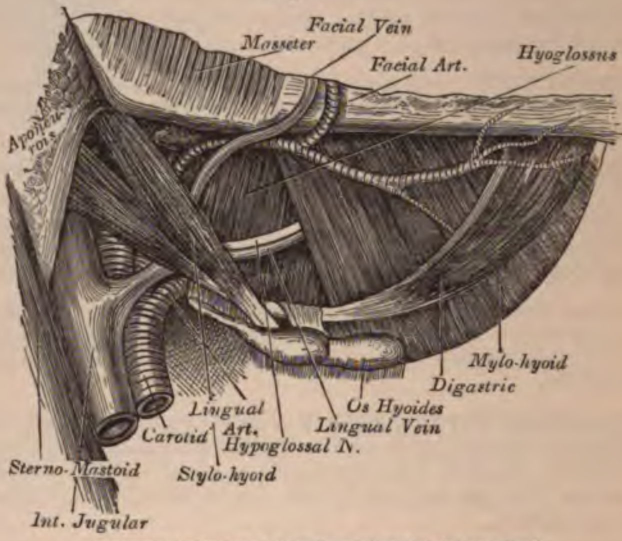
The lingual artery is the second branch of the external carotid; it arises just above the superior thyroid, ascends to the great cornu of the hyoid bone, runs parallel with it and passes inwards on the middle constrictor and genio-hyoglossus to the outer edge of the hyoglossus muscle; it then passes upwards and inwards beneath the digastric, stylo-hyoid, and hyoglossus muscles to the base of the tongue. The artery passes through three regions: 1, external to the hyoglossus muscle, (2) beneath the muscle, (3) from its inner margin to the tip of the tongue; the second portion is selected for ligation.

Operation.—Turn the head to the opposite side; make an oblique incision an inch and a half in length, a little above the body of the hyoid bone, and parallel with it, near the median line, and curved backwards, outwards, and downwards, parallel with the superior border of the great cornu of the thyroid cartilage; divide the superficial parts and with the finger recognize the direction of the great cornu; divide upon it the aponeurosis which covers the deep parts; this exposes the digastric muscle, the submaxillary gland, hypoglossal nerve, and stylo-hyoid muscle; now isolate the great cornu of the hyoid bone, and the fibres of the hyoglossus muscle, which are attached at this point, come into view; divide this muscle at the superior border of the great cornu; draw it upwards and backwards, and the artery is found behind it; the needle should pass from above downwards.

---

[1] J. A. Wyeth.

Fig. 280.



Anatomical relations of the lingual and facial arteries.[1]

Or, having recognized the position of the greater cornu of the hyoid bone, make an incision about an inch in length, parallel with, and about two lines above it, through the skin, cellular tissue, and platysma; this incision will expose the lower border of the submaxillary gland, on lifting which slightly, the shining tendon of the digastric will be recognized; less than a line below this lies the hypoglossal nerve, and at the distance of a line below the nerve, a transverse incision through the fibres of the genio-hyoglossus muscle will certainly expose the artery, which, in this situation, is accompanied by neither veins nor nerves.[2]

The facial artery (Fig. 280) arises a little above the lingual, is first directed obliquely forwards and upwards beneath the base of the maxillary bone, where it changes its direction and passes upwards over the base of the lower maxilla in front of the masseter muscle.

---

[1] Tillaux.

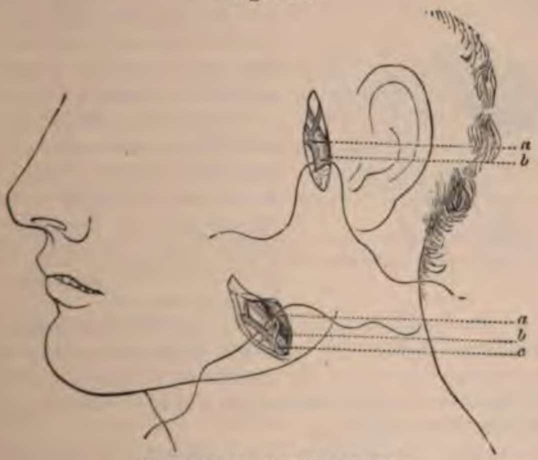
[2] J. F. Malgaigne.

It consists of a cervical and facial portion; the first is comparatively superficial, being covered only by the platysma and fascia, is crossed by the digastric and stylo-hyoid muscles, and then enters the submaxillary gland. Emerging from the gland the second part turns over the jaw, covered by the platysma and fascia, and ascends to the inner canthus of the eye.

Operation.—In the first part, make an incision similar to that for exposing the lingual artery, but nearer the base of the jaw, incise the skin and tissues over the submaxillary gland; draw the gland upwards and the artery will also be raised, when it can be easily separated from the vein and ligated. In the second part (Fig. 281) recognize at the junction of the posterior third with the anterior two-thirds of the body of the bone the pulsation of the artery; make an incision an inch in length, along the course of the vessel, as already given, through the skin, fascia, and platysma; the wound being separated, and the fibrous tissue divided, the artery, *c*, is exposed, and the vein, *b*, and masseter muscle, *a*, are drawn outwards, and the needle passed.

The temporal artery (Fig. 281) runs upwards towards the temporal region from its origin at the condyle of the jaw, in front of the concha; two inches above the zygoma it divides into the anterior and posterior branches.

Fig. 281.



The facial and temporal arteries.

Operation.—Recognizing the position of the artery by its pulsation, at a point above the zygomatic arch, and in front of the ear, make an incision through the skin, an inch in length; divide the dense cellular tissue on a director, and the artery, *a*, will be exposed; pass the needle from behind forwards to avoid the temporal vein, *b*, and the auriculo-temporal nerve.

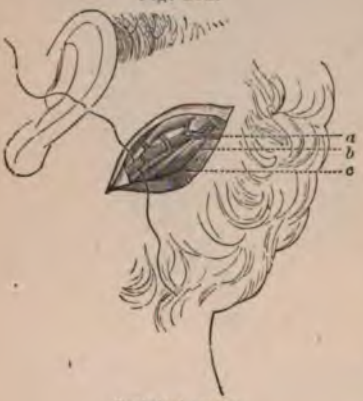
The middle meningeal artery is the largest branch of the internal maxillary, and the largest artery which supplies the dura mater.

It ascends under the external pterygoid muscle, and enters the skull through the spinous foramen of the sphenoid bone; within the skull it passes beneath the dura mater to the middle fossa where it divides into two terminal branches: the anterior, the larger, passes upward on the great wing of the sphenoid, in a deep groove in the anterior inferior angle of the parietal bone where it divides. This division may be ligated for intercranial hemorrhage. The artery is most accessible where it crosses the anterior inferior angle of the parietal bone.

Operation.—Determine the position of the artery by the intersection of a horizontal line drawn two inches above and parallel to the zygoma, with a vertical one an inch behind the posterior superior border of the malar bone; make a crucial incision through the skin, divide the temporal muscle, and expose the skull; the bone is unequally thick in this region, and care must be taken in using the trephine; the circle of bone being removed, the bleeding vessel may be ligated, or pressure may be employed to arrest hemorrhage.

The occipital artery arises from the posterior part of the external carotid, opposite or a little above the facial, ascends beneath the posterior belly of the digastric muscle to the space between the transverse process of the atlas and the mastoid process and is distributed to the occipital region.

Fig. 282.



Occipital artery.

(*a*) At its origin the artery is covered by the stylo-hyoid and digastric muscles, and the hypoglossal nerve winds around it from behind forwards.

Operation.—Make an incision along the inner border of the sterno-mastoid muscle, two inches in length, at the angle formed by this muscle and the digastric; the deep fascia being carefully divided, expose and isolate the artery, the nerve being protected.

(*b*) Behind the mastoid process (Fig. 282) the artery passes upwards, in a tortuous direction, and divides into branches, upon the occiput; it is covered by the sterno-mastoid and splenius muscles.

Operation.—Make an incision one inch long, half an inch behind and a little beneath the mastoid process, obliquely upwards and backwards; divide the skin and aponeurosis of the sterno-mastoid muscle, *c*, as also the splenius muscle, through the whole length of the wound; the pulsations of the artery, *a*, are recognized by the finger a little above the oblique muscle, *b*, and it is isolated from its veins.

The posterior auricular artery arises in the parotid gland nearly opposite the apex of the mastoid process; it ascends to the interval between the mastoid process and external auditory meatus, where it divides.

Operation.—Make a vertical incision midway between the two points above given; the pulsations of the artery will prove the immediate guide for its ligation.

The internal carotid artery continues directly upwards from the termination of the common carotid opposite the upper border of the thyroid cartilage to the carotid foramen of the temporal bone; at first it is covered only by the sterno-mastoid muscle, platysma myoides, and fascia; it lies to the outer side of the external carotid. Make the same incision as for the common trunk, its centre being one-half to three-quarters of an inch above the upper border of the thyroid cartilage; veins will be met with which must be avoided or tied; the descendens noni nerve runs along the artery, and the hypoglossal crosses it about one inch from its bifurcation. Pass the needle from the outer side, carefully avoiding the jugular vein and pneumogastric nerve externally, the hypoglossal nerve superficially, and the external carotid internally.

The internal mammary artery arises from the subclavian, on its lower and anterior part, opposite the thyroid axis, and close to the anterior margin of the scalenus anticus; it runs directly downwards and slightly inwards behind the clavicle on the inner surface of the costal cartilages near the sternum.

The internal jugular and subclavian veins and the phrenic nerve cross the upper part; in the chest it at first lies on the costal cartilages and intercostal muscles, covered by the pleura behind; but lower it is covered also by the triangularis sterni muscle; it may be tied in the second, third, or fourth intercostal spaces.

Operation.—Make an incision along the upper edge of the costal cartilage, commencing at the sternum, in either space, slightly upwards, and outwards, an inch and a half in length; divide the skin, cellular tissue, pectoralis major muscle, fascia, and intercostal muscle successively; a thin layer of cellular tissue is exposed, which conceals the artery; pass the needle cautiously from within outwards.

Or, make a vertical incision, commencing at the lower border of the clavicle, two inches and a half in length, parallel with and three lines from the external margin of the sternum.

The vertebral artery arises from the upper and back part of the subclavian artery in the first part of its course, about one-third of an inch internal to the inner border of the scalenus anticus muscle, and passes directly along the spinal column to the foramen in the transverse process of the sixth cervical vertebra, and then ascends through the series of foramina of the transverse processes to the cavity of the cranium.

(*a*) Before entering the vertebral canal the artery passes behind the internal jugular vein and inferior thyroid artery, to the spine, where it lies between the scalenus anticus and longus colli, and in a line drawn from the posterior part of the mastoid process to the junction of the internal fourth with the external three-fourths of the clavicle.

Its coverings in front are skin, superficial fascia, platysma, deep fascia, clavicular origin of sterno-cleido mastoid, second layer of deep fascia, internal jugular vein, inferior thyroid artery, and on the left side the thoracic duct; behind, is cellular tissue and apex of lung; outside, the thyroid axis; inside, the internal jugular vein and carotid artery.

Operation.—Place the patient on the back, the shoulder depressed, and the head turned to the opposite side; make an incision three inches in length along the inner border of the sterno-mastoid muscle between it and the sterno-hyoid, terminating at the middle of the upper extremity of the sternum; divide the skin, cellular tissue, and the aponeurosis uniting the sterno-mastoid muscle and sterno-hyoid; bring into view the common sheath of the carotid, the internal jugular and the pneumogastric nerve; separate with the finger the cellular connection of the sheath with the sterno-thyroid muscle, and finally with the longus colli; the head is now raised, though still turned to the opposite side; and the sides of the wound forcibly separated; divide the cellular tissue at the bottom, and expose an aponeurosis which passes from the scalenus anticus to the longus colli, and the anterior part of the transverse process of the sixth cervical vertebra, the carotid tubercle; then open the aponeurosis an inch below this point, at the external border of the longus colli muscle; the artery is exposed very deeply situated.

(*b*) Between the atlas and axis the artery lies in a triangular space formed by the rectus posticus minor and superior and inferior oblique muscles, and is covered by the rectus posticus major and complexus.

Operation.—Turn the head to the opposite side, and incline it forwards; make an incision two inches long on the posterior edge of the sterno-mastoid, commencing half an inch above the mastoid process; make a second incision, an inch in length, from the upper fourth of the first incision backwards and obliquely downwards; divide the skin and cellular tissue; then the splenius muscle with its fibrous expansion; a fibrous layer now appears, which must be cautiously divided to arrive at the small arteries which lie beneath it; the edges of the wound being separated, a layer of fat appears, which is cautiously opened with the finger or handle of the scalpel, and the artery is found within; the two branches of the occipital artery are to be drawn aside, as also branches of the second cervical nerve; the artery is isolated, and the needle passed from without inwards to avoid the internal carotid artery.

(*c*) Between the atlas and occiput the anatomical relations are as given above.

Operation.—The incisions are the same as in the last operation, except that the first commences one-fourth of an inch above the mastoid process; divide the skin, fascia, and splenius muscle; the occipital artery appears at the upper angle of the first wound, and is held aside; divide the underlying aponeurosis, with the cellular tissue; separate the edges of the wound, and in a triangle formed by the muscles of the part, the cellular tissue, loaded with fat, covers the artery; divide this and the artery is exposed; pass the needle from behind forwards.

The inferior thyroid artery is a branch of the thyroid axis; it ascends the neck obliquely, passing behind the internal jugular, the pneumogastric nerve, the carotid artery, and omo-hyoid muscle, to the thyroid body.

On the left side it lies on the œsophagus, and the thoracic duct is at first posterior and afterwards arches over it in front of the artery to the left subclavian vein; near the gland the recurrent laryngeal nerve often passes between its terminal branches.

Operation.—Make the same incision as for the ligature of the common carotid (Fig. 276). When its sheath is reached draw it outwards; the artery crosses obliquely inwards opposite this point; when the vessel is fully exposed apply the ligature as near the carotid as you can to avoid the recurrent laryngeal nerve.

ARTERIES OF THE UPPER LIMB.

The following general rules should guide in the ligation of arteries of the upper extremity for aneurism:—

Aneurism of the subclavian is usually fatal if left to itself, and surgical treatment has generally hastened death; if it occurs in the first or second part of the artery the ligature can only be applied to the innominate, if in the third part of the right, it must be applied to the first part of the same vessel; both operations have proved so fatal it is held that they do not warrant the trial.[1] The carbolized catgut ligature, used with all necessary antiseptic precautions, may prove, however, successful, as it does not involve the dangers of the division of the coats of the artery, nor of suppuration in the wound.[2] Axillary aneurism should first be treated by compression of the subclavian in its third part with the fingers or an instrument; if this fail, ligature of the subclavian in its third part may be resorted to. Or, especially in traumatic aneurism, the sac may be laid open, and the vessel found and tied,[3] pressure being made upon the subclavian over the first rib, an incision being made if necessary to reach the artery; the relation of the artery to the sac and the nerves is very variable.[1] Aneurisms of the vessels of the arm and forearm, if spontaneous, are commonly associated with disease of the heart or general arterial degeneration, and ought not to be actively treated;[1] if traumatic, they should be laid open and the vessel tied at the point where it is torn.

The subclavian artery arises from the innominate on the right side, and from the arch of the aorta on the left; it extends in a curved direction from its origin to the lower border of the first rib. It may be ligated in three places, viz., inside the scaleni, between the scaleni, and outside the scaleni muscles; the latter location is always to be preferred.

(*a*) Within the scaleni, on the right side, the artery passes upwards and outwards from its origin from the innominate across the neck to the internal border of the scalenus anticus muscle.

It is very deeply situated, and lies upon the pleura; its anatomical relations are, in front, the skin, fasciæ, platysma, origin of sterno-mastoid, sterno-hyoid, and thyroid muscles; it is also crossed by the pneumogastric, cardiac, and phrenic nerves, and by the internal jugular and vertebral veins; behind, it is in relation with the recurrent laryngeal and sympathetic nerves. On the left side the artery extends from the left portion of the arch of the aorta to the scalenus anticus, situated very deeply, and passing upwards, almost vertically; in addition to the anatomical relations of the right, the left has in front the pleura, the lung, and the carotid, and internally the œsophagus, trachea, and thoracic duct.

Operation.—The right subclavian is ligated thus: Place the patient on his back, the shoulders raised, and the head turned to the opposite side; make two incisions, one parallel with the inner part of the clavicle, and the other along the inner border of the sterno-mastoid;

[1] T. Holmes. [2] J. Lister. [3] J. Syme.

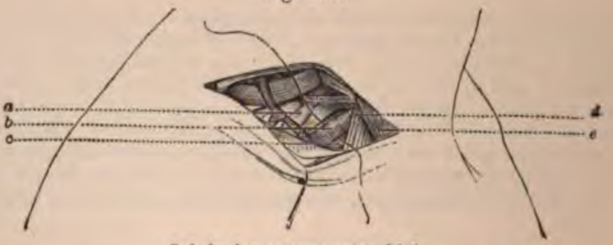
pass a director behind the sternal attachment of the sterno-mastoid, and divide the cellular tissue; avoid small arteries and veins in this part, and especially the anterior jugular; divide the sterno-hyoid and thyroid muscles on a director; open the deep fascia with the finger-nail, or end of the director, and expose the internal jugular, which being pressed aside, pass the needle around the artery from below upwards to avoid the pleura. The left subclavian is ligated thus: Place the patient in the position above described; make an incision three and a half inches long on the inner edge of the sterno-mastoid, terminating at the sternum, through the skin and platysma; this is met by another incision along the sternal extremity of the clavicle, two and a half inches; dissect the flap and divide the sternal and half the clavicular origin of the sterno-mastoid on a director, and raise the flap; divide the deep fascia with the handle of the scalpel and the fingers; continue the dissection along the outer side of the deep jugular vein to the upper edge of the scalenus anticus muscle, half an inch above the rib, to avoid the thoracic duct; the phrenic nerve is detected and avoided, and the fingers pressed to the bottom of the wound discover the rib, and then the artery; pass the needle from below upwards.[1]

(*b*) Between the scaleni the artery is very short; it is covered by the integuments, platysma, sterno-mastoid, and the scalenus anticus, upon which lies the phrenic nerve; below is the pleura and above the brachial plexus. The ligature has seldom been applied at this point.

Operation.—Make a deep incision; the tubercle of the rib being recognized, and the insertion of the muscle into it, pass the director behind it and between the muscle and the artery, and with a bistoury divide the muscle; its retraction exposes the artery, which is readily ligated; pass the needle from without inwards. Or, divide the muscle from without inwards, commencing some distance from the rib. The phrenic nerve is liable to be divided, unless this proceeding is adopted; the internal mammary artery may be wounded if the incision is too near the rib.

(*c*) Outside of the scaleni muscles (Fig. 283) the artery, *b*, passes downwards and outwards, lying in a groove on the first rib.

Fig. 283.



Subclavian artery; outer third.

It first passes through the supra-clavicular triangle, and is then covered only by the deep fascia, the platysma, and skin; lower in its course it is covered by the clavicle and subclavian muscle; the subclavian vein, *c*, lies lower and in front of the artery, *b*, separated from it by the insertion of the scalenus anticus muscle, *d*; the external jugular vein crosses in front of the artery; the brachial plexus of nerves, *a*, lies above and behind the artery. The depth of the artery may vary from one to three inches, according to the depth of fat (Fig. 284).

---

[1] J. K. Rodgers.

Fig. 284.

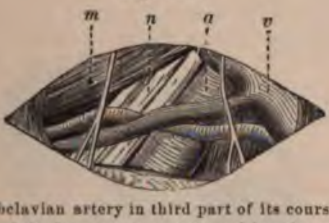


Diagram of the right subclavian artery in third part of its course, crossed by transversalis colli artery and vein. *a*. subclavian artery; *v*. external jugular receiving transversalis colli veins; *n*. brachial plexus of nerves; *m*. omo-hyoid muscle.

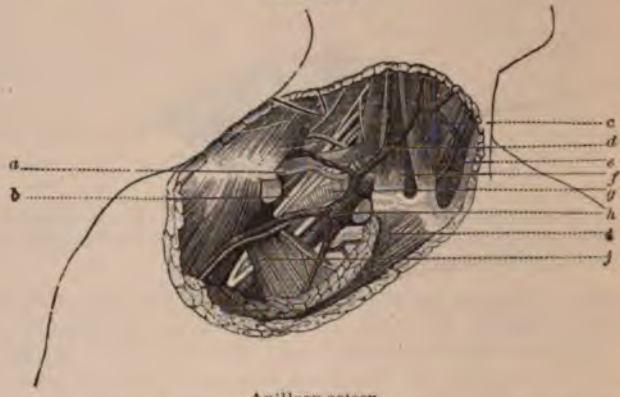
Operation.—Search for the artery (Fig. 283) in the supra-clavicular triangle, which is bounded externally by the omo-hyoid muscle, internally by the scalenus anticus, and below by the first rib; place the patient on his back, the shoulders depressed, and the head turned to the opposite side; the skin over the parts being drawn down upon the clavicle, make an incision along the bone, from the anterior border of the trapezius to the posterior border of the sterno-mastoid, *e*; divide the platysma and superficial fascia, care being taken to draw the external jugular outward, or, if cut, to tie the ends; with the director and finger separate the cellular and fatty tissue, and draw the omo-hyoid muscle aside; divide the deep fascia and the border of the scalenus, *d*, being defined, pass the finger along its margin down to the first rib, recognize the tubercle for the attachment of that muscle, just external to which the artery, *b*, will be felt pulsating; separate the attachments of the artery with the finger-nail, and gently insinuate the aneurism needle beneath it, from before backwards and slightly from within outwards, avoiding the vein, *c*; guide the point of the needle by the end of the finger, and prevent it, when it emerges upon the opposite side, from engaging a branch of the brachial plexus, *a*.

It must be remembered that the sterno-mastoid may have an unusually extended insertion upon the clavicle, as also the trapezius, in which case the incision must involve the clavicular attachments of the former; the external jugular, supra-scapular, and transverse cervical veins form a plexus immediately over the artery; the external jugular may run so near to the sterno-mastoid as to be involved in the incision, unless it is carefully isolated and drawn to the outer or inner side; the transverse cervical and supra-scapular arteries may be met with in this dissection, and if wounded should be immediately ligated; the tubercle of the rib is sometimes not well defined, in which case the tense edge and attachment of the scalenus to the rib is the guide to the artery, which is found just posterior to its insertion; there is a liability to include the lowest cord of the brachial plexus, or even to mistake it for the artery, the former is round and tense, the latter is flattened.

The axillary artery extends from the lower border of the first rib to the lower margin of the tendon of the latissimus dorsi, or the inferior boundary of the axilla, in a line dividing the anterior and middle third of the axilla. It may be ligated in two places.

(*a*) Below the clavicle (Fig. 285) in its upper part, the axill artery is covered successively by the insertion of the pectoralis min *j*; higher up by the pectoralis major muscle, *i*, from which it is se

Fig. 285.



Axillary artery.

rated by a layer of adipose tissue, containing numerous small ve and arteries; and finally by the fasciæ and the skin (Fig. 286).

The supra-scapular artery, *a*, crosses the base of the neck just above clavicle; the axillary vein, *h*, in front and to the inner side of the artery not in immediate contact with it; the cephalic vein passes upwards in interspace between the deltoid and pectoralis major muscles, crosses the axil artery above the pectoralis minor, and empties into the axillary vein; the ner *b*, of the brachial plexus, *c*, lie behind and above; a thoracic branch often cro the artery, sometimes in front, and sometimes behind it.

Fig. 286.

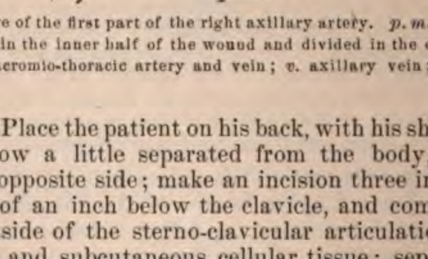
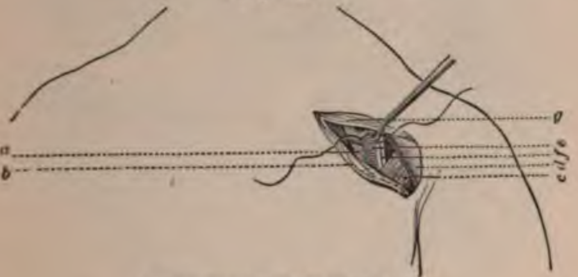


Diagram of ligature of the first part of the right axillary artery. *p. m. a.* pectoralis m the fibres separated in the inner half of the wound and divided in the outer; *p. m. i.* p ralis minor; *a. t.* acromio-thoracic artery and vein; *v.* axillary vein; *a.* axillary ar *n.* brachial plexus.

Operation.—Place the patient on his back, with his shoulders sligl raised, the elbow a little separated from the body, and the h inclined to the opposite side; make an incision three inches in len three-quarters of an inch below the clavicle, and commencing al two inches outside of the sterno-clavicular articulation, through skin, platysma, and subcutaneous cellular tissue; separate the fil of the pectoralis major gradually until the posterior investment of this muscle, like an aponeurosis, appears; now depress the shoulder and tear this fascia with the point of the director; press downwards and outwards with the finger the upper border of the pectoralis minor, when the axillary vein is brought to view; draw this gently forward with a blunt hook, and behind it the artery is found, with the nerves of the brachial plexus still further behind and above; pass the needle from within outwards.

Or (Fig. 287), make a transverse incision three inches in length, through the skin and platysma, along and upon the lower edge of the clavicle, three fingers' breadth from the sternal extremity of that bone, and terminating an inch from the acromion process of the scapula; make a second incision, three inches in length, obliquely through the integuments, over the deltoid and pectoral muscles, meeting the first nearly in the centre; remove the cellular membrane and fat; detach the clavicular portion of the pectoralis major, *g*, *b*, and remove the cellular tissue overlying the subclavian vessels; the artery now appears and its pulsations are detected; the pectoralis minor, *c*, and the margin of the deltoid, *d*, are brought to view, and the artery, *e*, is isolated from the vein, *a*, lying in front, and the brachial plexus behind.

Fig. 287.



Axillary artery below the clavicle.

(*b*) Below the pectoralis minor, in its lower half, the artery is superficial, covered only by the integuments and deep fascia.

The coraco-brachialis muscle is in contact with the artery, and may be found at its internal and posterior border; the branches of the brachial plexus of nerves surround the artery, the musculo-cutaneous lies along the outer side; the two roots of the median meet in front, at the lower border of the pectoralis minor; the nerve then lies in front and to the outer side of the artery; the internal cutaneous lies in front and to its inner side; the ulnar and radial are still further within and behind; the axillary vein is in front of the artery and nerves, which it partly conceals (Fig. 288).

Fig. 288.

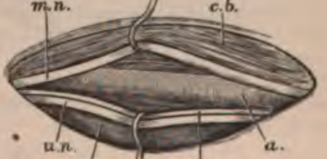
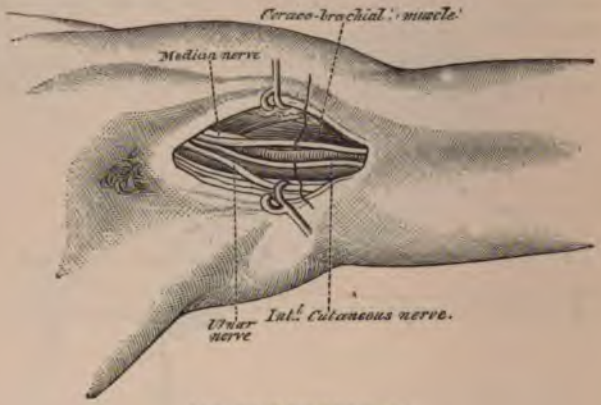


Diagram of ligature of the axillary artery in its lower third. *c. b.* coraco-brachialis; *m. n.* median nerve; *u. n.* ulnar nerve; *i. c. n.* Internal cutaneous nerve; *v.* vein; *a.* artery.

Operation (Fig. 289).—Place the patient on the back, the arm rotated outwards; stand on the outside if it is the right arm, and on the inner side if the left; recognizing the inner border of the coraco-brachialis muscle and the pulsations, make an incision two or three inches in length in the line indicated, dividing only the skin; incise the fascia on a director; with the end of the director push the axillary vein backwards, then the brachial plexus; the median nerve is now recognized, and being brought forward, while the internal cutaneous and ulnar are pushed backwards, the artery is exposed; separate the artery carefully from the vein, which is pushed backwards, and the nerves which surround it, and pass the needle from behind forwards.

Fig. 289.



Ligature of brachial artery.

The brachial artery extends from the lower margin of the axilla to an inch below the bend of the elbow, in a line drawn from the junction of the anterior with the middle third of the axilla to the middle of the bend of the elbow.

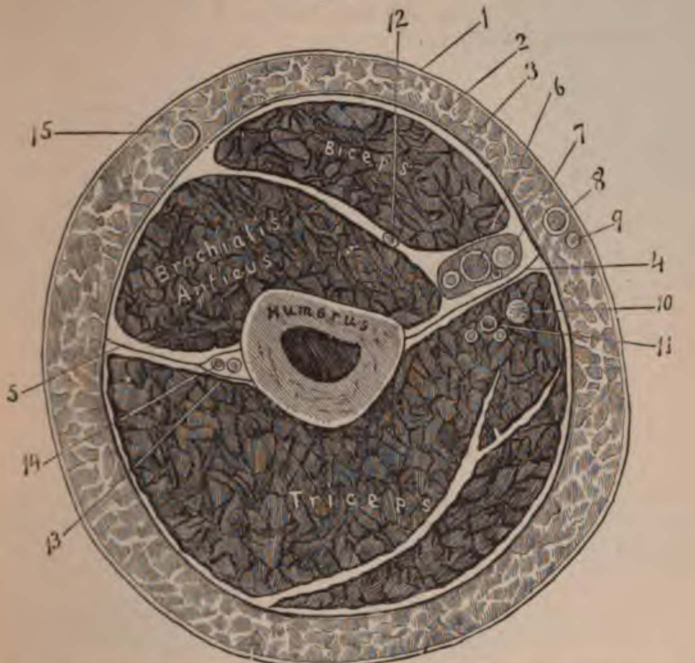
(*a*) *Operation.*—In the upper third, the arm being extended as before, make an incision two and a half inches in length along the inner border of the coraco-brachialis; the artery is readily exposed, lying between and behind the median and ulnar nerves, the former to the outside, and the latter to the inside.

(*b*) In the middle of the arm the brachial descends on the inner side, first of the coraco-brachialis, and afterwards of the biceps.

It is covered by the fascia and integuments, and overlapped slightly by the biceps; its sheath contains the two venæ comites; the internal cutaneous nerve lies superficial to it; the median is superficial to it above, and rather to its outer side; about the middle of the arm it crosses the artery, and inferiorly it is to its ulnar side; the ulnar nerve is internal to the artery, and at some distance from it inferiorly; the spiral nerve is posterior, and separates it above from the triceps (Fig. 290).

Operation (Figs. 291, 292).—The arm extended at right angles to the body, and held supine, the course of the artery may be recognized by its pulsation; by the internal margin of the biceps and coraco-brachialis; by the median nerve, to the inner side of which it lies; or by the line above given. Make an incision two or three inches in

Fig. 290.



Transverse section of the arm at its middle. 1. Skin. 2. Subcutaneous tissue. 3. Enveloping aponeurosis. 4. Aponeurosis separating the anterior and posterior loges on the inner side. 5. Division on the outer side. 6. Brachial artery and veins. 7. Median nerve. 8. Basilic vein. 9. Internal cutaneous nerve. 10. Ulnar nerve. 11. Its artery and veins. 12. Muscular cutaneous nerve. 13. Muscular spiral nerve. 14. Superior profunda artery. 15. Cephalic vein.

length, along the inner border of the biceps, down to the fascia, which incise on a director; the position of the median nerve is detected in the wound; push it aside with the biceps; the artery is found immediately behind and inside, accompanied by its venæ comites. The arm is now flexed, the vessel isolated and the ligature passed from without inwards.

Fig. 291.

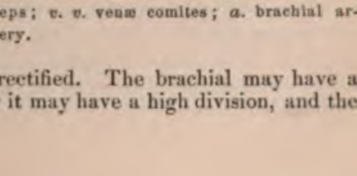
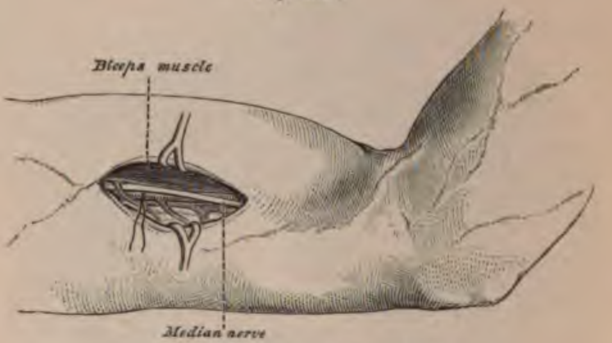


Diagram of the parts concerned in ligature of the brachial in the middle of the arm. *m. n.* median nerve drawn inwards; *b.* biceps; *v. v.* venæ comites; *a.* brachial artery.

If the incision is made a little too far back the ulnar nerve is exposed, and is liable to be mistaken for the median; and this error may be confirmed by the presence of the vein, occupying the same relative position as the brachial to the median, which may be mistaken for the artery. If it is remembered that the ulnar nerve here passes downwards and backwards, the error will be rectified. The brachial may have a high division into the radial and ulnar; or it may have a high division, and the branches again unite in the arm.

(*c*) At the elbow the brachial artery lies in the centre of a triangular space, formed by the supinator longus, externally, and the pronator radii teres, internally.

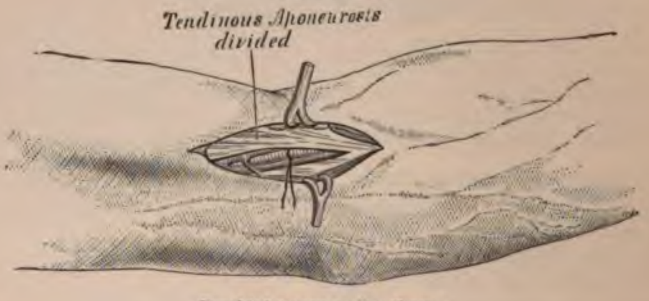
Fig. 292.



Brachial artery in the middle of the arm.

It rests on the brachialis anticus; the median nerve lies to the inner side half an inch; the tendon of the biceps lies on the outer side; its coverings are the skin, superficial fascia, and the median basilic vein, which is separated by the bicipital fascia.

Fig. 293.



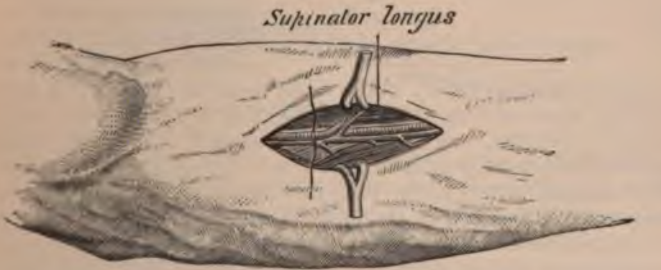
Brachial artery at the elbow.

The arm extended and held in a supine position (Fig. 293), make an oblique incision, two inches and a half in length, along the internal edge of the tendon of the biceps, within the median basilic vein, dividing only the skin; push aside the vein and divide the aponeurosis, which is the deep fascia, on a director; the tendon of the biceps is now seen, and on its inside the artery with its two veins, and still farther inward the median nerve; slightly flex the forearm, and pass the needle from within outward, carefully avoiding the veins.

The radial artery, though the smaller branch of the brachial, lies in the direct course of the latter like a continuation; its course is marked by a line drawn from the centre of the elbow to the inner side of the styloid process of the radius; is superficial throughout nearly its entire course; the needle may be passed in either direction.

(*a*) *Operation* in the upper third; the artery lies between the supinator longus and the pronator radii teres; the radial nerve lies immediately on its external side (Fig. 294). The limb being extended supine, the superficial veins made prominent by pressure of the thumb above, make an incision two or three inches in length, on the internal border of the supinator longus, if recognized by the depression, or on a line drawn from the middle of the bend of the elbow to the inner side of the styloid process of the radius, dividing the skin and superficial fascia; divide the deep fascia on a director; flex the arm slightly to relax the muscles; the supinator longus being drawn aside, the sheath of the artery is exposed; pass the needle from without inwards.

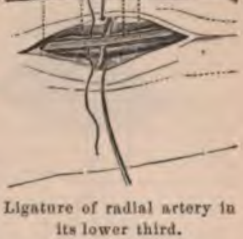
Fig. 294.



Ligature of radial artery.

(*b*) *Operation* in the lower third; the artery is superficial, lying between the tendons of the supinator longus and the flexor carpi radialis; it is accompanied by venæ comites, and by the radial nerve which lies external; its pulsation is easily detected (Fig. 295). The arm held supine, the hand forcibly extended to make prominent the flexors, and the operator standing on the external side of the limb, make a light incision two inches in length, from half an inch above the articulation of the radius, on the external border of the flexor carpi radialis, or on a line joining the external with the three internal fourths of the arm; the deep fascia, *a*, is raised on a director, exposing the artery, *c*, with its two veins, *b*, and the nerve, *d*, external and posterior; the needle may be passed in either direction.

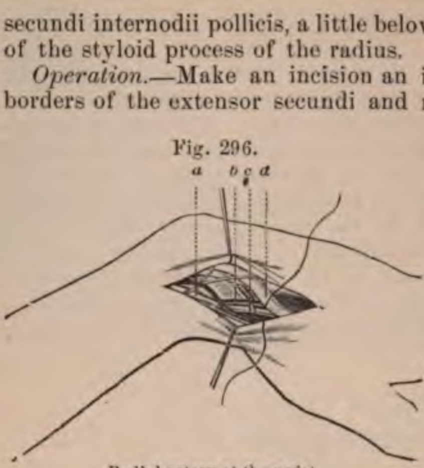
Fig. 295.



Ligature of radial artery in its lower third.

(*c*) On the dorsum of the wrist (Fig. 296), the artery passes in the groove between the upper extremities of the first metacarpal bones; a fibrous band separates it from the tendons of the thumb. It may be tied, just as it is about to form the palmar arch, or, as it passes under the extensor muscle of the thumb, between the extensor primi internodii and the extensor secundi internodii pollicis, a little below and posterior to the extremity of the styloid process of the radius.

Fig. 296.



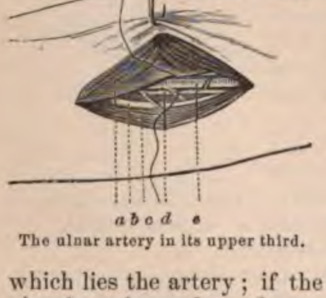
Radial artery at the wrist.

Operation.—Make an incision an inch in length along the outer borders of the extensor secundi and metacarpi pollicis, at the angle formed by the two first metacarpal bones, care being taken not to wound the superficial veins; the artery is readily exposed. At the higher point, place the hand between pronation and supination, the thumb strongly abducted so as to render prominent the extensors, and make an incision an inch in length, between the tendons of the two extensors, commencing at the lower extremity of the radius, and in the line of the axis of the first metacarpal bone; make these incisions lightly, to avoid the superficial vein of the thumb; draw the extensor ossis metacarpi pollicis, *a*, inwards, and the extensor secundi internodii pollicis, *d*, outwards; expose the artery, *c*, and its accompanying veins, *b*.

The ulnar artery, the larger terminal division of the brachial, passes to the inner side of the forearm, at the lower part of its upper third, continues along the ulnar side to the wrist, passes over the annular ligament, on the outer side of the pisiform bone, and terminates in the superficial palmar arch. Its course is marked by a line drawn from the internal tuberosity of the os brachii to the external side of the pisiform bone.

(*a*) In its upper third, the ulnar artery, arising from the brachial, curves inwards deeply beneath the flexor muscles, and passes along the ulnar side of the forearm, between and covered by the flexor carpi ulnaris and flexor sublimis digitorum; it is accompanied by two veins, and by the ulnar nerve, which is more superficial and internal.

Fig. 297.

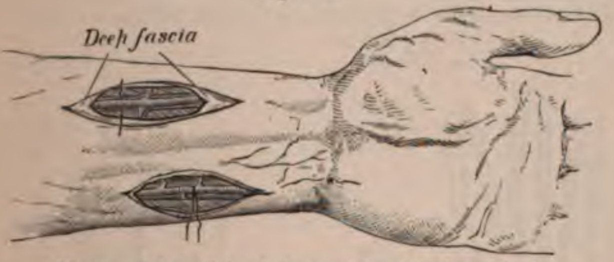


The ulnar artery in its upper third.

Operation (Fig. 297).—The forearm being supine, the hand extended and inclined to the radial side, make an incision on the imaginary line given, three inches in length, and beginning three fingers' breadth below the internal condyle through the skin and superficial fascia, and recognize the aponeurotic connection of the flexor carpi ulnaris and flexor sublimis, which is of a yellowish-white color; divide it on the director from below, where it is the most delicate, carefully avoiding the division of muscular substance; the flexor sublimis, *a*, is drawn outwards, and the deep aponeurosis exposed, under which lies the artery; if the vessel is not seen, press the flexor carpi ulnaris, *c*, inwards, and expose the ulnar nerve, *b*, a little external to which lies the artery, *e*, with its two veins, *d*; isolate the artery by flexing the arm slightly and the hand strongly; pass the needle from without outwards.

(*b*) *Operation* in the lower third; the artery is superficial, having upon its inner side the flexor carpi ulnaris and ulnar nerve, and upon its external side the flexor sublimis digitorum. Place the arm supine, and extend the hand so as to make prominent the tendon of the flexor carpi ulnaris; then along the radial border of this muscle (Fig. 298), or at the union of the external four-fifths of the arm with the internal fifth, or on a line drawn from the internal condyle to the pisiform bone, make an incision about two inches in length, through the skin and subcutaneous cellular tissue; raise the deep fascia on a director, or with the forceps, and incise it, exposing the tendon of the flexor carpi ulnaris; this should be pressed inwards, and immediately behind it the artery will be found with its two accompanying veins, and the nerve upon the inside.

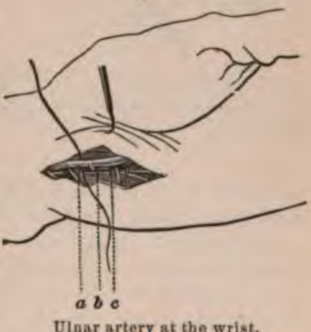
Fig. 298.



Ligature of the radial and ulnar arteries at the lower third.

(*c*) *Operation* at the wrist (Fig. 299); the artery lies to the radial side of the pisiform bone, and is accompanied by its veins, *b*, and the ulnar nerve, *c*, which lies on its internal and posterior aspect. The hand being held back, make a slightly curved incision on the radial side of the pisiform bone, through the skin and adipose tissue, about three inches in length, its concavity looking inwards; the artery, *a*, is deeply seated in a groove, and the dissection should be continued along the side of the pisiform bone until it is exposed; the latter part of the dissection will be facilitated by flexing the hand upon the forearm; pass the needle beneath from within outwards.

Fig. 299.



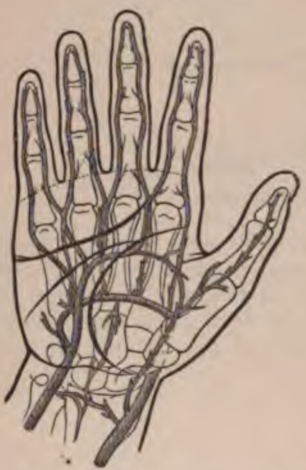
Ulnar artery at the wrist.

The superficial palmar arch is the continuation of the ulnar artery into the hand (Fig. 300). Near the lower border of the annular ligament this artery turns obliquely outwards across the palm of the hand towards the middle of the muscles of the thumb where it inosculates with a small branch of the radial, the superficialis volæ.

At its commencement it rests on the annular ligament of the wrist and slightly on the short muscles of the little finger, then on the tendons of the superficial flexor of the fingers and the divisions of the median and ulnar nerves, the latter nerve accompanying the vessel for a short distance; it is covered towards the ulnar border of the hand by the palmaris brevis and the palmar fascia and integument.

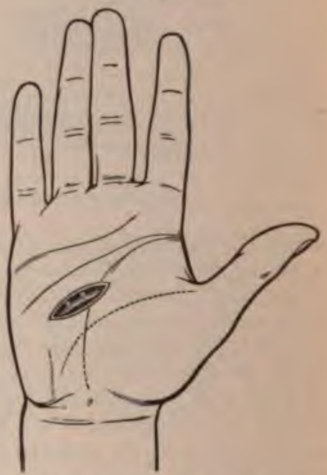
The central portion of a transverse line drawn across the palm, from the angle of the web between the thumb and index-finger, corresponds pretty accurately with the position of the middle of the superficial palmar arch; if the thumb be abducted its anterior surface is (Fig. 301) continuous in direction with the palmar outline of the ball of the thumb, which will then become parallel to the middle palmar fold; the vessel lies parallel to and equidistant between them.[1]

Fig. 300.



Position and mode of formation of the palmar arches and distribution of the digital arteries.

Fig. 301.



Method of finding the position of the superficial palmar arch and the direction and exact position of the wound which would have to be made in order to reach it.

Operation.—Make an incision one inch long midway between and parallel to these lines, and nearly opposite to the bases of the middle and ring fingers; divide the skin and palmar fascia, and the arch will be brought to view at the thicker part of the ulnar artery[1] (Fig. 301).

The deep palmar arch (Fig. 300), a continuation of the radial artery, commences at the upper end of the first interosseous space between the heads of the adductor indicis, turns transversely across the palm towards the fourth metacarpal bone, and inosculates with the communicating branch of the ulnar artery; it rests on the interosseous muscles and on the metacarpal bones immediately below their carpal extremities, and is covered by the flexor brevis pollicis, the flexor tendons of the fingers, and the muscles of the little finger. This artery is seldom ligated; the guide must be the wound.

---

[1] Sir W. MacCormac.

ARTERIES OF THE LOWER EXTREMITY.

Aneurisms of the arteries of the lower portion of the body, for which the ligature has been applied, now give the following indications as to the treatment:[1]—

Abdominal aneurism, if of the aorta, must, as a general rule, be restricted to rest and medical measures only; some of the aneurisms affecting the lowest part of the vessel may be under the influence of pressure applied to the artery as it lies on the spine just above the origin of the mesenteric; the artery has been successfully compressed where it lies between the pillars of the diaphragm;[2] pressure is now a recognized surgical proceeding very far superior to the ligature of the aorta, but is dangerous from protracted anæsthesia, contusion of the viscera, and injury to the great sympathetic ganglia and nerves; when employed, the patient's bowels should be freed, the walls relaxed by bending, full but not deep anæsthesia produced, and the tourniquet applied.

Gluteal aneurism, if traumatic and approaching the character of a recent wound, should be laid freely open and the artery tied, the sac being plugged with the finger,[3] or the tourniquet being applied to the aorta; compression of the aorta or common iliac, galvano-puncture, or injection of coagulating fluids, are justifiable measures; if the aneurism extend into the pelvis the internal iliac may be ligated. Pressure upon the trunk of that artery might possibly be effected by the fingers, the hand being introduced into the rectum.[4]

Ilio-femoral aneurism should first be treated by instrumental pressure, under an anæsthetic, of the common iliac or the aorta; if pressure fail, resort to ligature of the common iliac. In aneurism of the common femoral the external iliac artery must be tied.

Popliteal aneurisms forming on the anterior face of the vessel, known by the distinct line of pulsation in the course of the artery lying over the tumor, are rarely cured by any other measure than the ligature, and this often fails, rendering amputation necessary. In treatment of the more common form, growing from the back, or partly from the side of the artery, marked by absence of any distinct line of pulsation, early implication of the nerve, and swelling of the foot and leg, digital or instrumental pressure on the femoral should be made; if it is very small, flexion may first be tried; if these methods fail, or if the aneurism is extending, and in all the severe forms not demanding amputation, the ligation is the safest course. Incision of the sac,[5] the old operation, with antiseptic measures has proved useful in certain cases which otherwise would demand amputation, viz., in large aneurisms interfering with the circulation below, when ruptured and diffused, when the knee-joint is involved by pressure, when the sac inflames and suppurates, when ligation of the femoral and compression have failed. Operate as follows: arrest the circulation in the aneurism by a tourniquet applied to the upper third of the thigh; make an opening in the sac, introduce the finger and break up the clots; then lay the sac freely open, remove all the clots, and search for the opening of the artery into the sac; these being found, introduce a No. 10 bougie into one and pass the aneurismal needle, armed with a prepared catgut ligature, under and around the artery, and ligate; repeat the operation on the other opening; remove the tourniquet, cleanse the sac with sublimate solution, 1 to 2000, fix the drainage tube in the cavity and close the wound with antiseptic dressings.

The abdominal aorta lies in front and a little to the left side of the bodies of the vertebræ, having the vena cava on its right side, the sympathetic nerve on its left, and the left lumbar veins behind; it divides on the lower part of the fourth lumbar vertebra at a point nearly corresponding to the umbilicus; it may be ligated about one inch above its bifurcation, between it and the origin of the mesenteric. It can be exposed and successfully ligated by the operation for the common iliac; the artery being separated from the vein, with the finger or a director pass the needle from right to left. Or, make an incision along the linea alba, three inches in length, the middle of it on a level with the umbilicus, but a little to the left; open the peritoneum; push the intestines aside; detect the artery by its pulsations, separate the peritoneal covering with the finger nail on the left side, carry the finger under the vessel, and pass the needle;[1] or, make an incision from the extremity of the tenth rib downwards six inches, curving backwards to within an inch of the anterior spine of the ilium, Q, and reach the aorta from the side by raising the peritoneum.[2] All the antiseptic precautions of peritoneal section must be enforced.

---

[1] T. Holmes.

[2] Murray.

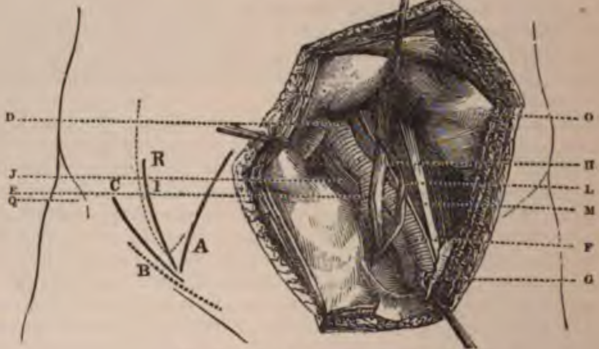
[3] J. Syme.

[4] W. H. Van Buren.

[5] T. Annandale.

The common iliac artery (Fig. 302) varies from three-quarters of an inch to three inches in length, averaging about two;[3] it passes from the bifurcation of the abdominal aorta, on the left side of the body of the fourth lumbar vertebra, a point corresponding with the left side of the umbilicus, on a level with a line drawn from one crista ilii to the other, downwards and outwards along the margin of the pelvis to the sacro-iliac synchondrosis; the artery upon the right side is on an average the same length as that upon the left,[3] and has in front the peritoneum and at its point of division the ureter. The following method of operating is now to be preferred:—

Fig. 302.



Dissection of the common iliac

Behind, the accompanying vein, J, is partly external above, but below it lies behind and slightly internal; on the outer side, the common iliac vein above, and the psoas muscle, M, below. The left common iliac has the rectum and superior hemorrhoidal artery in front, the left common iliac vein internal and partly beneath, and the psoas magnus external.

Operation.—Provide large flat aseptic sponges, small sponges with sponge-holders, hot sublimate solutions for douche, spatulæ, and an aneurism needle armed with a carbolized silk or catgut ligature cleanse the surface of the abdomen and empty the bladder. Make an incision in the median line four inches in length, commencing at the symphysis, through the superficial tissues down to the linea alba; ligate all bleeding vessels; open this aponeurosis at the upper end of the incision cautiously by raising a fold with forceps and cutting with the point of the knife; divide it throughout on the director; in the same manner incise the transversalis fascia, thus exposing the peritoneum; raise a fold of the peritoneum with forceps and open it with the point of the knife, and then enlarge the opening on the fingers. Now, with the flat sponges, wrung out of hot bichloride solution, push the intestines gently upwards until the region of the artery is fully exposed; if the intestines are so distended that they cannot be pushed upwards out of the way, draw them gently out of the wound upon the abdomen, first covered with towels rung out of the hot sublimate solution, and keep them covered with the hot sponges. Drawing the side of the wound towards the artery with a spatula the vessel will be fully exposed; avoiding the ureter pick up the sheath of the artery with forceps; open it with the point of the knife on the inner aspect, and uncover the vessel; pass the needle from within outward. After ligating the artery cut the ends of the ligature; with the small sponges remove the blood, if there is any, from the cavity, return the bowels gently with as little manipulation as possible; close the peritoneal and deep fascial wound by the continuous catgut suture, and the external wound with wire or silkworm catgut, taking a deep suture including all of the tissues down to the transversalis fascia. The remaining dressings should be dry and antiseptic.

---

[1] Sir A. Cooper. [2] Murray. [3] L. Holden.

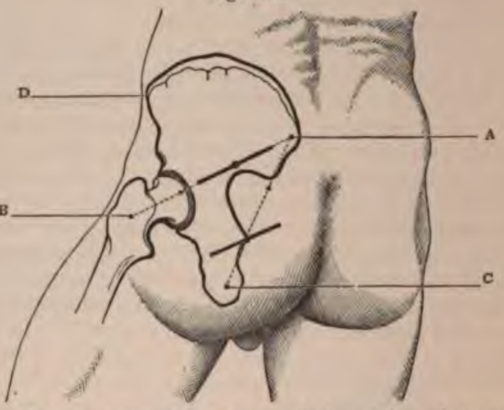
If the operation be performed without opening the peritoneum, antiseptics should be employed, and the following method pursued: The patient being placed on the back (Fig. 303), inclining to the opposite side; make an incision, R, commencing just anterior to the extremity of the eleventh rib downwards, one and a half inches within the anterior superior spine, and terminating just above the internal ring by a sharp curve upwards and inwards of an inch; the entire length is about seven inches; divide the integuments and superficial fascia; then the three abdominal muscles; cautiously raise the fascia transversalis from the peritoneum, first at the upper part of the wound where the union is slightest; now gently elevate the peritoneum and press it inwards from the iliac fossa towards the pelvis; the pulsations of the external iliac, F, are first recognized, and the finger carried upwards along this vessel reaches the common trunk; the ureter, H, in front, is carefully pushed aside, and the needle passed from within outwards.

The internal iliac artery, E (Fig. 302), is an inch and a half in length, extending from the bifurcation of the common iliac downwards and forwards to the upper margin of the great sacro-sciatic foramen; it is in relation anteriorly with the ureter, H, which separates it from the peritoneum; posteriorly, with the internal iliac vein; it rests on the sacral plexus of nerves and the pyriformis muscle; on the left the rectum lies partially over it. The artery may be exposed and ligated by the methods described in the operation on the primitive iliac.

The gluteal artery emerges from the pelvis, at the upper part of the great ischiatic notch, above the upper border of the pyriformis muscles.

It is covered by the gluteus maximus muscles, and is accompanied by tw veins; a line drawn from the posterior superior spine of the ilium to the top the great trochanter marks the course of the artery (Fig. 303).[1]

Fig. 303.



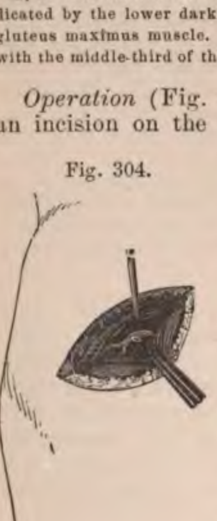
Position and direction of the superficial incisions which must be made to secure the gluteal artery and the sciatic or pudic arteries. *A.* Posterior superior iliac spine. *B.* Great trochanter. *C.* Tuberosity of the ischium. *D.* Anterior superior iliac spine.

A, B. Ilio-trochanteric line, divided into thirds. This line corresponds in direction with the fibres of the gluteus maximus muscle. The incision to reach the gluteal artery is indicated by the darker portion of the line. Its centre is at the junction of the upper with the middle-third of the ilio-trochanteric line and exactly corresponds with the point of emergence of the gluteal artery from the great sciatic notch.

A, C. Ilio-ischiatic line. The incision to reach the sciatic artery, or internal pudic, is indicated by the lower dark line. It is also to be made in the direction of the fibres of the gluteus maximus muscle. The centre of the wound corresponds to the junction of the lower with the middle-third of the ilio-ischiatic line.

Operation (Fig. 304).—Place the patient upon his belly, make an incision on the line above indicated, four or five inches long, terminating about an inch and a half from the spine; the cut is parallel with the fibres of the gluteus maximus, which should be separated, and the finger introduced to detect the pulsations of the artery; separate the pyriformis and gluteus medius muscles, the borders of which cover the vessel, and isolate the artery from its veins and pass the needle as deeply as possible as the artery divides just after its emergence.

Fig. 304.



Ligature of gluteal artery.

The sciatic artery escapes from the pelvis between the pyriformis and coccygeus muscles, and descends in the interval between the trochanter major and tuberosity of the ischium.

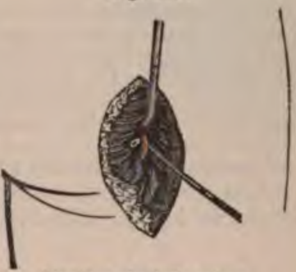
It is covered by the gluteus maximus, and is accompanied by the sciatic nerve, and the vein which lies to its posterior and inner side; the centre of a line drawn from the posterior superior spinous process of the ilium to the tuberosity of the ischium, marks the point of exit of the artery from the pelvic cavity.

---

[1] Sir W. MacCormac.

Operation (Fig. 305).—The patient being prone, make an incision, four inches in length, the centre of which falls upon the point of emergence of the artery, as given above; divide the skin, cellular tissue, and the fibres of the gluteus maximus; the artery is found to the inside of the nerve, and must be carefully isolated from the vein.

Fig. 305.



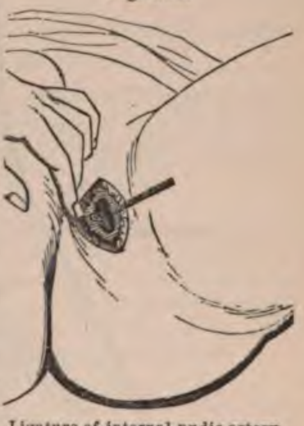
Ligature of sciatic artery.

The internal pudic artery, the smaller of the two terminal branches of the internal iliac, passes out of the pelvis through the great sacro-sciatic foramen, internal to the sciatic artery; it again enters the pelvis through the lesser sacro-sciatic foramen, runs along the ramus of the ischium and pubis, and divides into the arteries of the penis.

(*a*) At the greater sacro-sciatic foramen make the same incision as in the ligature of the sciatic artery; the pubic is found a little internal, accompanied by its veins and the pudic nerve.

(*b*) In the perineum (Fig. 306) the artery may be ligated as it descends the ramus of the ischium; draw a line from the middle of the pubes to the internal border of the tuber ischii. The patient being placed in the position for lithotomy, make an incision two inches in length along the ramus of the pubis, near the arch; by careful dissection the vessel is found along the inner border of the ramus, where it may be isolated and the ligature applied; care should be taken not to incise the corpus cavernosum.

Fig. 306.



Ligature of internal pudic artery

The dorsalis penis artery reaches the dorsum of the penis by passing between the crura, and runs forward, through the suspensory ligament, in the groove of the corpus cavernosum, to the glans, distributing branches in its course to the body of the organ, skin, and prepuce. It is enveloped in the subcutaneous layer, and is accompanied by the dorsalis penis nerve and vein; the latter structures should be remembered in ligating the artery. Make an incision three-fourths of an inch in length, commencing two inches in front of the pubes directly in the median line; carry the incision through the skin and superficial lamina of the subcutaneous layer, when the artery is fully exposed; pass a small artery needle, carefully avoiding the nerve.[1]

The external iliac artery, about four inches in length, passes obliquely downwards and outwards, from the sacro-iliac symphysis to Poupart's ligament, in a line drawn from the left side of the umbilicus to a point midway between the anterior superior spine of the ilium and the symphysis pubis; it may be ligated in any part of the course, except near its upper and lower extremities.

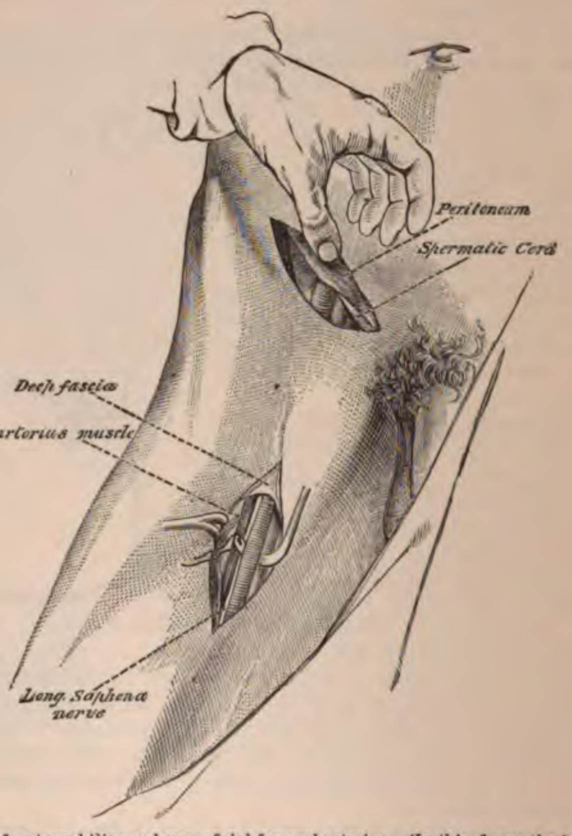
---

[1] J. C. Hutchison.

In its upper portion it has in front the peritoneum and intestines, and near Poupart's ligament the spermatic vessels, genito-crural nerve, circumflex iliac vein, lymphatic vessels and glands; externally, the psoas magnus, from which it is separated by the iliac fascia; internally, the external iliac vein; below, and curving along its side, the vas deferens; behind, it rests above upon the external iliac vein, which gradually passes to its internal side.

Operation.—Place the patient in a recumbent position, the muscles relaxed by elevation of the pelvis; make an incision three or four inches in length (Fig. 307), commencing about an inch and a half within the anterior superior spine of the ilium and on a level with this process, and extending in a curved direction downwards and inwards,

Fig. 307.



Ligature of external iliac and superficial femoral arteries. (In this figure the incision for the femoral artery is placed too low.)

nearly parallel with Poupart's ligament, and terminating an inch and a half above it, just outside of the external abdominal ring. On the left side it will be found convenient to commence the incision internally, at the external ring and carry it upwards and outwards to the point indicated within the anterior superior spine. Incise the integuments and fascia, and tie the superficial epigastric artery, if divided; the aponeurosis of the external oblique muscle is now exposed and divided on a director; in the same manner divide the fibres of the internal oblique and transversalis muscles until the transversalis fascia, recognized by its white, opaque appearance, is exposed; cautiously open this membrane and incise on the director; the peritoneum is now exposed and carefully detached from the iliac fossa, and pushed towards the pelvis; the artery is readily felt pulsating at the bottom of the wound, along the inner border of the psoas muscle, the vein being on the inner aspect, the genito-crural nerve external; open the sheath and insinuate the needle beneath it, from within outwards, to avoid the vein. Or, the finger may be passed into the internal ring along the spermatic cord and the iliac fascia raised in this manner.

Other incisions are made in the course of the artery (Fig. 302, A),[1] three inches in length; a curved incision (Fig. 302, C),[2] commencing a little above the spine of the ilium, and terminating a little above the internal edge of the inguinal ring; an incision (Fig. 302, B)[3] in the centre of the space between the interior spine and the symphysis pubis.

The epigastric artery, G (Fig. 302), arises from the anterior face of the external iliac above Poupart's ligament.

It at first descends and then passes obliquely upwards and inwards between the peritoneum and the transversalis fascia, in a line drawn from the middle of Poupart's ligament to the umbilicus; it lies behind the inguinal canal, and to the inner side of the internal abdominal ring; it has two veins nearly to its origin.

Make an incision as in the last operation, but not so long, the centre being under the middle of Poupart's ligament; raise and divide the tendon of the external oblique on the director; now turn up the lower border of the fibres of the internal oblique and transversalis muscles; carefully tear through the transversalis fascia, when the artery will be exposed near its origin; separate it from its veins, and ligate.

The circumflex iliac artery arises from the outer side of the external iliac artery near Poupart's ligament, and is directed behind that band to the anterior superior spine; it lies in front of the transversalis fascia at the junction of this with the iliac fascia. It may be ligated by the same incision as that given for ligation of the epigastric; tear through the transversalis fascia and the artery will be found running parallel with Poupart's ligament, having two veins.

The femoral artery extends from Poupart's ligament to the tendinous opening in the adductor magnus muscle, at the junction of the middle and lower third of the thigh, in a line drawn midway between the anterior superior spine of the ilium and the symphysis pubis, and the inner side of the internal condyle.

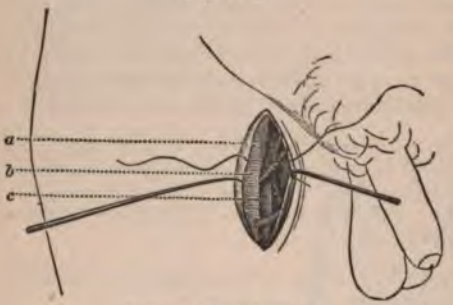
---

[1] J. Abernethy. [2] Sir A. Cooper. [3] Bogros.

The artery is generally and most easily ligated in Scarpa's space. Ligation of the common femoral has proved very fatal by causing gangrene of the limb, especially when tied for wounds.

(*a*) The common femoral artery extends from Poupart's ligament to the origin of the deep femoral about one inch and a half. It is superficial, being covered by the skin, superficial and deep fasciæ, and lymphatic glands; the vein lies on its inner side, and the anterior crural nerve half an inch to its outer side; the vessels lie in a canal formed by the parting of the two layers of the fascia lata, and are separated by this septum. Half or three-quarters of an inch below Poupart's ligament will probably be the most favorable locality for ligature.[1]

Fig. 308.



Common femoral artery.

Operation.—The pulsation being recognized, midway between the anterior superior spine of the ilium and the pubes, make an incision two inches in length, over the artery, commencing at the crural arch; divide the skin and cellular tissue; raise the fascia, *a*, on a director, and expose the sheath; open it and examine for the origin of the profunda and epigastric; draw the vein, *c*, inwards, and pass the needle around the artery, *b*, from within outwards, ligating it above the profunda femoris. The incision may be parallel[2] with Poupart's ligament.

In persons of ordinary flesh, the fold of the groin corresponds exactly with Poupart's ligament, but in those who are very fleshy the fold is somewhat below Poupart's ligament; and should this be taken as the guide to the commencement of the incision there would be danger of applying the ligature just below the origin of the profunda; it is advisable to bring the ligament into view before the ligature is applied, and pass the needle a finger's breadth below.

(*b*) The superficial femoral artery lies in a triangle, Scarpa's space, formed by Poupart's ligament above as its base, the sartorius externally, and the adductor brevis internally; it is very superficial, being covered by integument, the superficial and deep fasciæ, and lymphatic glands; the vein is on the inner and slightly posterior part (Fig. 309). Ligate near the apex of the triangle.

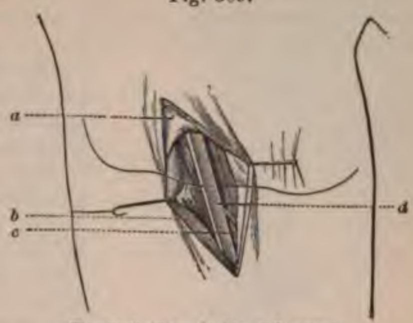
Operation.—Abduct and place the thigh on its external aspect; make an incision commencing about four inches below Poupart's ligament, along the inner margin of the sartorius muscle, three inches in length; the saphenous vein, first made prominent by pressure above, is left to the inner side; divide the fascia lata, *a*, expose and draw outward the sartorius, *b*, and the sheath of the vessels becomes apparent; the position of the artery is recognized by its pulsations; open the sheath

---

[1] L. McL. Tiffany.

[2] Porter.

Fig. 309.



Femoral artery in Scarpa's space.

to a sufficient extent to pass the needle, which is cautiously done from within outwards to avoid the vein, *c*; the point of the needle should be kept close to the artery, *d*, as the vein lies closely on its inner and posterior aspect.

If the saphenous vein is wounded, compression is sufficient for its treatment: if the incision falls upon the sartorius, this must be drawn aside.

(c) The middle portion of the femoral artery is covered by the skin, superficial and deep fasciæ, and sartorius, and is contained in a fibrous canal; the femoral vein lies on the outer and posterior part of the artery, and the long saphenous nerve more externally.

Operation.—Place the limb in position, and make an incision three or four inches in length at the middle of the thigh, on the line given, or on the inner border of the sartorius muscle, its upper extremity being six lines, and the lower two lines from the internal border of that muscle, care being taken to avoid the internal saphenous vein, the course of which is made apparent by compression above; expose the sartorius by dividing the fascia lata; draw it outwards; expose and divide the fibrous connection between the vastus and adductor muscles; the sheath of the vessel now appears, which is readily opened, and the needle passed from within outwards, avoiding the vein and long saphenous nerve (Fig. 310).

Fig. 310.

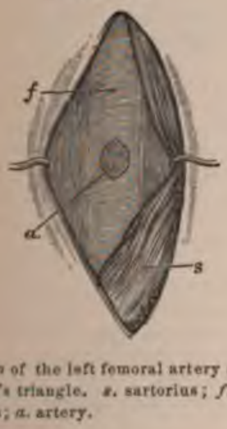


Diagram of the left femoral artery at apex of Scarpa's triangle. *s.* sartorius; *f.* femoral sheath; *a.* artery.

Fig. 311.

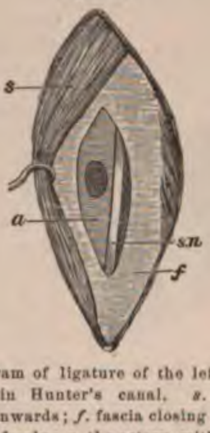
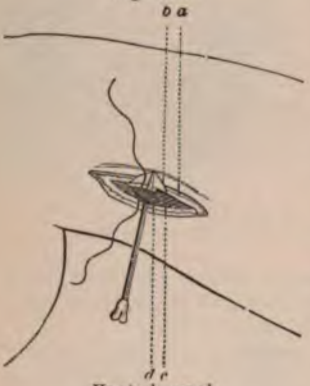


Diagram of ligature of the left femoral artery in Hunter's canal. *s.* sartorius drawn inwards; *f.* fascia closing the canal, opened freely; *a.* the artery, with a small opening in its sheath for the passage of the needle; *s. n.* long saphenous nerve.

(*d*) At the inferior part of its course the femoral artery enters a fibrous sheath, formed by the fibrous bands which extend from the vastus internus to the adductor magnus and longus, having over it the sartorius muscle, fasciæ, and integuments (Fig. 311).

Operation.—Flex the thigh on the pelvis, the limb resting on its external surface; make an incision three inches long on the outer margin of the sartorius muscle (Fig. 312), if recognized, or on the line above given; the skin being divided, the sartorius, *c*, recognized, and the fascia, *a*, divided on a director, two lines within its external border; draw the muscle backwards and divide the posterior part of its sheath; the space between the vastus internus and adductor magnus is now recognized, which contains the canal of the artery; open this canal, *b*, on a director, and the artery, *d*, is exposed, with the vein on its inside, and the saphenous nerve on the outside; the vessels are united by very dense cellular tissue, and great care is necessary to isolate the artery.

Fig. 312.



Hunter's canal.

The popliteal artery extends from the opening in the adductor magnus to the lower border of the popliteus muscle, in an oblique direction downwards and outwards.

In the popliteal space the external saphenous vein runs perpendicularly in the median line, and in the middle of the popliteal space perforates the deep fascia; then ascends, winds around the popliteal nerve, and empties into the popliteal vein (Fig. 313). It is accompanied by the external saphenous nerve, from which it is separated by a process of the deep fascia; the popliteal nerve passes down the middle of the popliteal space, beneath the deep fascia, superficial to, and on the outside of the popliteal vessels, from which it is separated by adipose tissue; it gives off the external saphenous and the peroneal nerves; the popliteal artery is covered in its whole course, and crossed at the middle of the popliteal space, by the popliteal vein, the direction of which is vertical; the artery, always beneath the vein, is somewhat internal to it above, and external to it below; the vessels are covered superiorly by the belly of the semi-membranosus; below they pass between the two heads of the gastrocnemius. They are connected together, throughout their course, by dense cellular tissue, which renders their separation difficult.

Fig. 313.

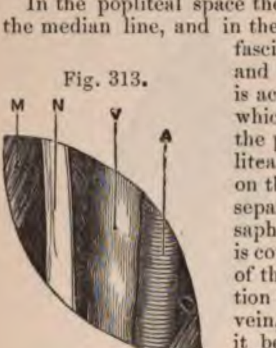
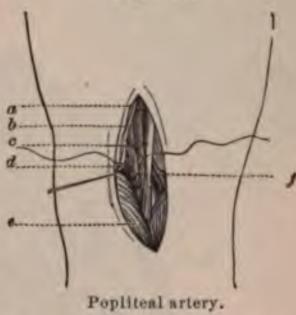


Diagram of left popliteal artery. *A.* Popliteal artery. *V.* Vein. *N.* Internal popliteal nerve. *M.* Biceps muscle.

(*a*) *Operation*, in its upper part; make an incision three inches in length, from the inferior third of the thigh, and passing along the external margin of the semi-membranosus muscle; divide the skin and fascia; separate the cellular tissue with the director and finger; now flex the leg, and the nerve first appears, then the vein on its inside, and lastly the artery; pass the needle from within outwards.

(*b*) *Operation* in its lower part (Fig. 314); the patient is laid on his face, and an incision made through the integument, three inches long, slightly on the outside of the median line; the external saphenous vein, *f*, which lies under the skin, is carefully avoided; the fascia, *a*, is divided, and the cellular substance in the space between the two heads of the gastrocnemius is separated with the finger, exposing the popliteal nerve, *c*, the vein, *b*, and most external, the artery, *d*; the nerve and vein are drawn inwards, and the needle is passed from within outwards.

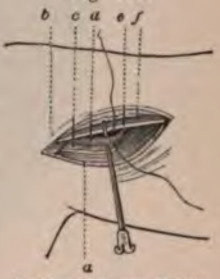
Fig. 314.



Popliteal artery.

(*c*) *Operation* below the internal condyle (Fig. 315); the patient on his back, the limb lying on the outer side, standing on the outside feel for the internal side of the muscular mass bounding the popliteal space internally and below; make an incision, *b*, two and a half inches in length, from above downwards, from without inwards, and from behind forwards, along the edge of the internal head of the gastrocnemius, within half an inch of the internal border of the tibia; care is taken to avoid the internal saphenous vein, *f*; divide the aponeurosis a little farther back than the skin; introduce the finger to break down the intermuscular septum, the leg being flexed on the thigh to relax the muscles; at the bottom of the wound is seen the nerve, *e*, to the inside, the artery, *d*, and the accompanying vein, *c*, drawn outwards.

Fig. 315.



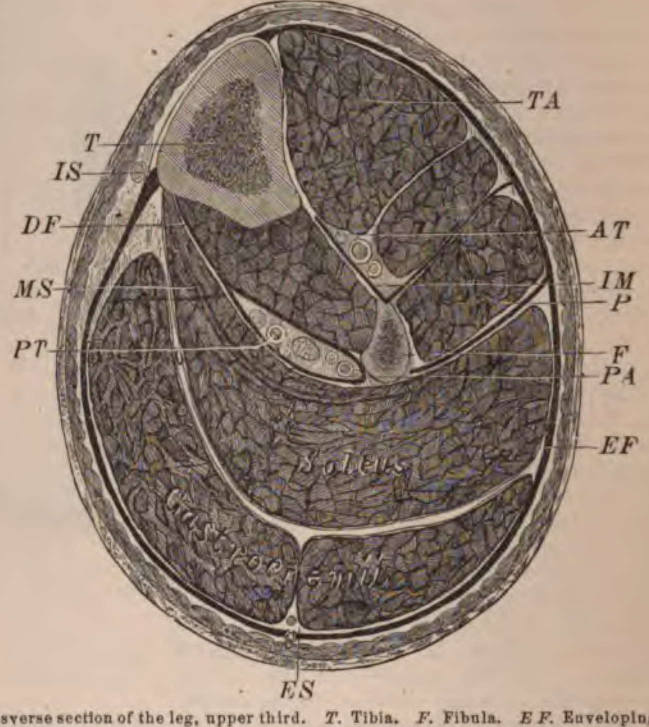
Popliteal artery below the internal condyle.

The posterior tibial artery, a branch of the popliteal artery, extends from the lower border of the popliteus muscle, in an oblique direction, from without inwards to the annular ligament; its course is in a line commencing in the centre of the popliteal space and terminating behind the internal malleolus (Fig. 316).

(*a*) *Operation* at its upper third; the artery is covered by the tibialis posticus, the deep aponeurosis, the soleus, and the gastrocnemius. The limb being placed on its outer side, the knee flexed, make an incision at least four inches in length, at a distance of two-thirds of an inch from the internal border of the tibia through the integuments and deep fascia; carry the index finger into the wound, detach and push outwards the internal head of the gastrocnemius, and divide also the attachments of the soleus, thus exposed, from the posterior surface of the tibia; whilst an assistant keeps this muscle held backwards and outwards with a blunt hook, divide the deep layer of aponeurosis upon a director, and search for the vessel immediately beneath; detach the artery, and pass the ligature beneath it with the artery needle.

(*b*) *Operation* in its middle third; the artery runs parallel with the inner border of the tibia, from which it is separated by the flexor longus digitorum; it is covered by the internal border of the soleus, it has venæ comites, and the posterior tibial nerve is on its inner side (Fig. 316). The limb is placed as in the last position, and an incision made three inches in length, three-fourths of an inch posterior to the internal border of the tibia; the integument and deep fascia being divided, the fore border of the gastrocnemius is seen and drawn backwards, exposing the soleus; the fibres of this muscle should be divided on a director; the artery is now felt pulsating about an inch from the margin of the tibia; the pearl-colored deep aponeurosis which overlies is divided, and then the muscles relaxed by the position of the limb; the artery is isolated from its veins, the nerve being pressed to the outside; the needle is passed from without inwards (Fig. 317).

Fig. 316.



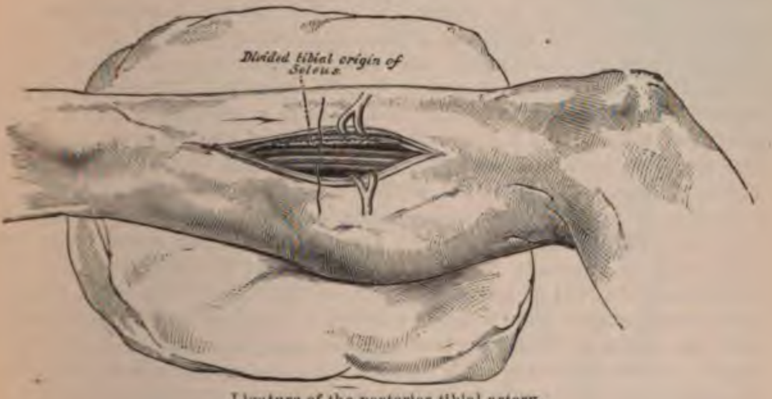
Transverse section of the leg, upper third. *T.* Tibia. *F.* Fibula. *E F.* Enveloping fascia. *D F.* Deep fascia dividing to inclose. *P T.* Posterior tibial artery and nerve, and *P A.* Peroneal artery. *T A.* Tibialis anticus muscle. *A T.* Anterior tibial artery and nerve. *I M.* Interosseus membrane. *P.* Peroneus longus muscle. *I S.* Internal saphenous vein. *E S.* External saphenous vein and nerve.[1]

---

[1] Tillaux.

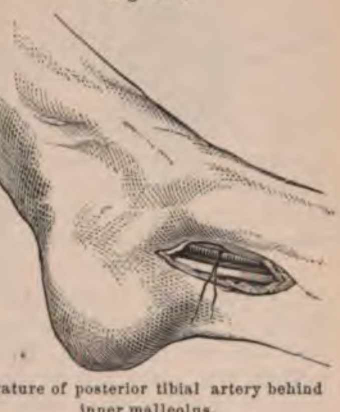
(*c*) *Operation* in its lower third; the artery passes behind the internal malleolus, at first parallel with the tendo Achillis, and then midway between the internal malleolus and the tuberosity of the os calcis; it is very superficial, and is in relation anteriorly with the tendons of the tibialis posticus and flexor longus digitorum, and posteriorly with the posterior tibial nerve; it has venæ comites (Fig. 318). The leg being placed on its external aspect, the foot flexed, make an incision two inches in length, a finger's breadth posterior to the inner edge of the tibia, and parallel with it; the integuments are divided, the deep fascia, raised on a director, and a small mass of fat opened, which will expose the artery, and the venæ comites, and the posterior tibial nerve; the sheaths of tendons should be carefully avoided; it should be noticed that the artery sometimes lies anterior to the incision here given. The artery may be ligated a little lower by making a curved incision one-third of an inch behind the external malleolus. At this part of the leg the anastomosis of large branches of the internal saphenous vein are numerous, and generally run transversely; these may be brought out by compressing the trunk of the vein above, and thus be avoided, at least in part.

Fig. 317.



Ligature of the posterior tibial artery.

Fig. 318.



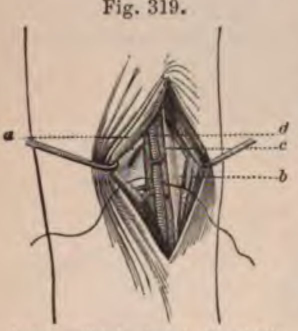
Ligature of posterior tibial artery behind inner malleolus.

The anterior tibial artery emerges upon the anterior part of the leg, at its upper part, through the interosseus membrane, about the level of the lower margin of the tuberosity of the tibia, and passes down to the ankle, in a line drawn from the inner side of the fibula to point midway between the two malleoli; the anterior tibial nerve is closely applied to the outside of the artery throughout; it may be ligated at any point in its course.

(*a*) *Operation* in its upper third; the artery lies between the tibialis anticus and extensor longus digitorum; having their origin in part from the deep fascia, the intermuscular septum is not easily recognized, nor are the muscles readily separated. The limb being turned inwards, the foot extended, take as a guide the line already given, or a point ten lines to the outer side of the spine of the tibia, and make an incision about four inches in length through the integument; divide the deep fascia with a crucial incision to allow of its complete separation; the intermuscular septum is now sought for, and may be recognized: (1) As the first intermuscular space from the tibia; (2) on pressure from within outwards the resistance of the other muscles; (3) at the lower part of the wound the white line of the muscular interspace is more marked. The foot being flexed, separate the muscles with the index finger, and, the wound being held apart, expose the artery with its two veins and nerve, the latter being outside; pass the needle from without inwards, avoiding the nerve.

(*b*) *Operation* in its middle third; the artery is covered by the deep fascia; on the inner side it has the tibialis anticus muscle, and on the external the extensor longus digitorum and extensor proprius pollicis (Fig. 319). The limb being placed as in the former position, make an incision three inches or more in length, in the course of the artery, through the integument; the septum in the deep fascia uniting the two muscles is recognized by a white line; divide it longitudinally, and also by a crucial incision; flex the foot to relax the muscles, and the wound being separated by drawing the tibialis anticus, *b*, internally, and the extensor longus digitorum and extensor proprius pollicis, externally, the nerve is met with more superficially than the artery, *d*, with its veins, *c*; pass the needle from within outwards, avoiding the nerve.

Fig. 319.



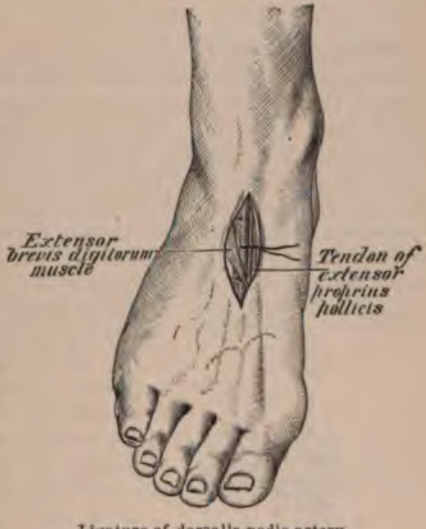
Anterior tibial artery in its middle third.

(*c*) *Operation* in its lower third; the artery is covered by the fascia, and is crossed by the extensor proprius pollicis; it lies at first between the tibialis anticus muscle and the extensor proprius pollicis, the latter muscle crossing to the inner side; the artery lies between the tendon of this muscle and that of the extensor longus digitorum; it is accompanied by venæ comites and the anterior tibial nerve, which here lies to the outer side. The leg being placed in a horizontal position, the foot extended, and the tibialis anticus muscle recognized, make an incision along the external border of that muscle, on the line already indicated, three inches in length, but not extending to the annular ligament; carefully incise the deep fascia on a director, and find the space between the tibialis anticus and extensor proprius pollicis, and separate the two muscles with the index finger;

now flex the foot, and expose the artery, resting on the tibia with the nerve superficial to it; isolate it from the two veins, and pass the needle from within outwards, the nerve being drawn inwards. If the incision falls between the extensor proprius pollicis muscle and the extensor communis digitorum, the ligature may still be applied.

The dorsalis pedis artery terminates the anterior tibial, and runs in a line drawn from the middle of the intermalleolar space, measured from the extremities of the malleoli to the space between the first metatarsal bones.

Fig. 320.


Extensor brevis digitorum muscle
Tendon of extensor proprius pollicis

Ligature of dorsalis pedis artery.

It is covered by the integuments, fascia, and innermost tendon of the extensor brevis digitorum; on its inner side is the extensor proprius pollicis, and externally, the inner tendon of the extensor longus digitorum; it has two veins, and on its external aspect is the anterior tibial nerve.

Operation.—Make an incision (Fig. 320) two or three inches in length parallel to the external border of the tendon of the extensor proprius pollicis muscle; divide the skin and deep fascia, on a director, and draw the internal division of the extensor brevis digitorum outwards, exposing the artery and its accompanying veins; the nerve is on the outside; pass the needle from within outwards.

The peroneal artery arises from the posterior tibial, and runs along the inner border of the fibula to the outer side of the os calcis; its course is marked by a line drawn from the posterior part of the head of the fibula to the external border of the tendo Achillis, at the malleolus; it may be ligated just below the middle of the leg.

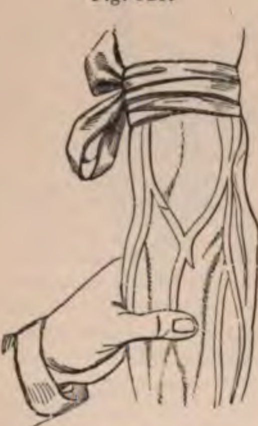
Operation.—Make an incision two or three inches long, one or two lines behind the external edge of the fibula and parallel with it; if the soleus is met with, it must be separated from the fibula and drawn inwards; the edge of the bone being now exposed, separate the attachments of the flexor proprius pollicis to its posterior surface, and the artery is found at its internal side; the muscle has a strong aponeurosis on its anterior surface, which must be divided, as the artery lies under it.

The plantar arteries, branches of the posterior tibial, enter the sole of the foot in the hollow of the calcaneum. The internal is a small artery which passes along the inner margin of the sole above the abductor pollicis. The external is the larger; it first passes obliquely outwards and forwards to the base of the fifth metatarsal bone; it then turns obliquely inwards across the foot, to the interva between the bases of the first and second metatarsal bones, where it joins the dorsal artery by a branch, thus completing the plantar arch. At first the artery lies between the calcaneum and the abductor pollicis, then between the flexor brevis digitorum and flexor accessorius, and as it turns forwards it lies between the short flexor of the toes and the abductor of the little toe. These arteries are ligated for injuries.

III. THE VEINS.

Venesection, or blood-letting from a vein, is performed with the thumb lancet; this instrument may have a very blunt or a very acute point; the former is preferred in operations on superficial, the latter on deep-seated veins. The patient may be seated or recumbent, but in general the position should be chosen which most enlarges the vessels; stop the flow of blood to the heart by a ligature applied around the part on the proximal side of the point selected for the operation, sufficiently firm to close the veins and still leave the arteries unobstructed; the veins now become prominent unless the person is very fleshy, when the position of the vein must be determined by its corded feel; place the thumb of the left hand firmly on the vein (Fig. 321), a little to the distal side, to prevent the vessel from rolling on the attempt to puncture it; hold the lancet between the thumb and index finger of the right hand, the blade at an obtuse angle with the hand; plunge it into the vein obliquely to its transverse diameter, and the hand being fixed, elevate the point of the lancet so as to cut its way out.

Fig. 321.

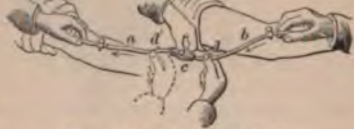


Venesection.

The success of the operation is determined by the flow; if this should be slight, it may be due to too small an orifice, which should then be enlarged; or to a mass of protruding fat, which may be pushed aside. If an increased flow is required, the patient should be directed to grasp repeatedly the staff, or the operator may rub the limb from the wrist towards the elbow. When the proper amount of blood is drawn, as proved by the fainting of the patient, the band should be removed, and a small compress being placed over the wound, apply a figure-of-eight bandage; to prevent air entering the circulation in bleeding from the jugular, pressure on the wound should be made before the compress is removed. Blood may be taken from any of the superficial veins, but those of the neck, the bend of the arm, and at the ankle, are generally selected. In the neck the external jugular is preferred. Place a compress over the vein in the supra-clavicular fossa, and firmly retain it by a bandage passed over it and under the opposite axilla; place the index finger of the left hand upon the vein above, and make the incision upwards and outwards across the platysma myoides. At the bend of the elbow select the cephalic vein on account of its isolation; the basilic is the largest, but, as the brachial artery passing directly under it is in danger of being wounded, first determine the position of the artery, then pass a band firmly around the arm above the elbow; with his hand the patient must grasp a staff; standing in front of the patient, grasp the arm with the left hand, placing the thumb on the distended vein, and the fingers on the back of the elbow, and holding the lancet in the right, open the vessel. At the ankle select the internal saphena; first place the foot in a vessel of warm water to distend the veins, then pass a band around the leg, just above the malleoli; place the thumb on the vein, and open it just above the inner ankle, with an oblique incision.

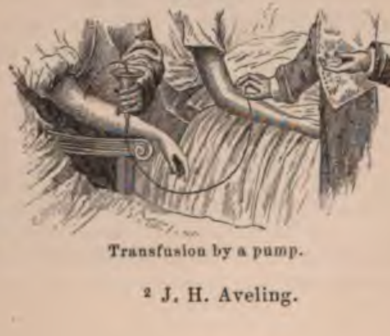
Transfusion is the injection of the blood of one person into the bloodvessels of another to relieve extreme exhaustion. It is more useful after severe hemorrhages when the vascular tension is slight, than in chronic diseases in which the vessels are already filled to about their natural capacity; in the latter cases, especially if associated with fatty degeneration of the heart, but a small amount of blood should be introduced at one sitting—six ounces—lest too much strain be placed upon the heart.[1] The operation is performed upon the veins, and the blood may be transferred directly from one person to another. Or it may first be drawn into a vessel and then be injected. Immerse the apparatus (Fig. 322)[2] in a basin of tepid water and expel the air by compressing the bulb; select a prominent vein at the bend of the elbow; place a bandage on the arm; raise a fold of skin over the vein; transfix and divide; seize the vein with fine forceps, and make a V incision with scissors; take the tube, *a*, from the water with the thumb over its orifice to keep it full, and insert it into the vein; the arm of the blood donor is now brought into close proximity, and the vein opened, and the tube, *b*, inserted as described; the India-rubber part of the apparatus, filled with water and kept so by turning the cocks at each end, is now fitted into the two tubes; the cocks are opened and the injection commenced by compressing the India-rubber tube on the efferent side, *d*, and squeezing the bulb, *c*; this forces two drachms of water into the afferent vein; next shift the hand from *d* to *d'*, and compress the tube on the afferent side, allowing the bulb to expand slowly, when blood will be drawn into it from the effer-

Fig. 322.



Transfusion by a bulb tube.

Fig. 323.



Transfusion by a pump.

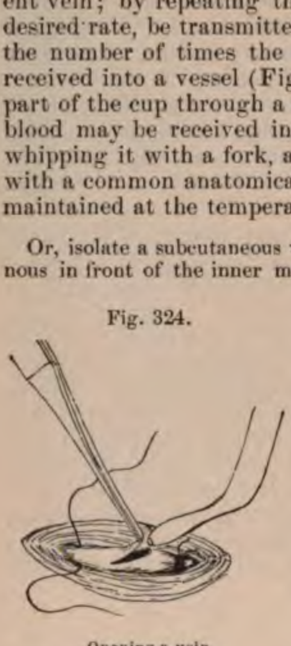
---

[1] J. R. Chadwick.

[2] J. H. Aveling.

ent vein; by repeating this process, any quantity of blood can, at desired rate, be transmitted, the amount being measured by countin the number of times the bulb is emptied. The blood may first b received into a vessel (Fig. 323) and then be pumped from the lowe part of the cup through a canula into the veins of the patient; or th blood may be received into a vessel, if desired, and defibrinated b whipping it with a fork, and then injected, the fibrin being remove with a common anatomical syringe, the blood and instruments bein maintained at the temperature of 100° F.

Fig. 324.



Opening a vein.

Or, isolate a subcutaneous vein at the bend of the elbow, or the large saph nous in front of the inner malleolus by a free incision through the skin an tissues, and pass under it a catgut ligature each end of the wound; tie the distal ligatur raise the vein between the two ligatures by small pair of toothed forceps, and with a pa of scissors directed towards the proximal po tion make an oblique incision with a long flap raise the flap and introduce the nozzle of th canula (Fig. 324) made of glass, hard rubbe or silver, and retain it in position by tying th second ligature.[1]

Transfusion of blood as a remedial measur has not gained the confidence of surgeons. is difficult to employ it in emergencies, an there is a liability that masses of fibrin, eve in defibrinated blood, will enter the circulatio and act as emboli. It is now believed, als that the blood-corpuscle is not the importa element, but that the true indication is t restore activity to the circulation by increasing the amount of vital flui which has a dynamic force on the heart and nervous system. Accordingl the tendency now is to prepare a fluid nearly allied to the fluid elements of th blood, and inject that into the circulation as follows:—

Saline injections into the veins have been practised wit much success in cases of loss of blood, and in the anæmia of surgic affections. It is a remedy of undoubted value, and the surgeon shoul be prepared to avail himself of it at any moment. The injection ma be made in emergencies with the common bulb syringe, but grea care must be taken to avoid injecting air, and it would be better t inject into an artery, as the ulnar at the wrist. The fluid is prepare as follows: Of sodium salts, take chloride 6 grs., phosphate 3 grs sulphate 1.5, carbonate 20 grs.; of potassium chloride 6 grs. Di solve in 24 ounces of water at 100° F. The fluid should enter th vein at a rate not exceeding one ounce per minute until 12 to 2 ounces are used.

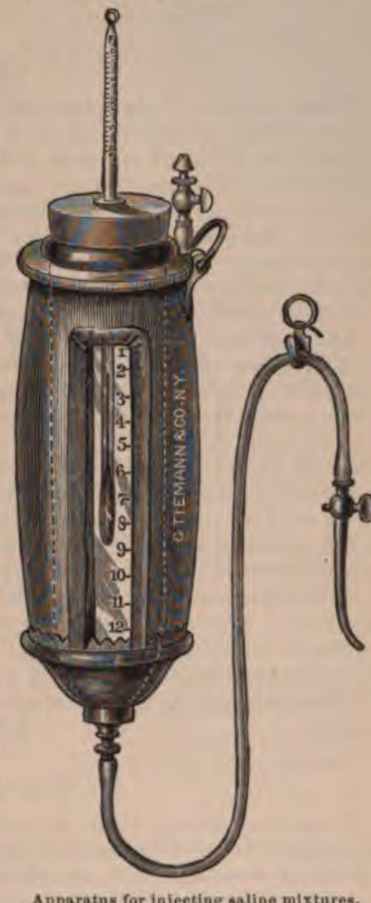
A useful apparatus for making these injections is described as follows:[2] Th apparatus consists of a cylindrical glass receiver, graduated into inches, with capacity of twelve ounces; a metal cap, containing a perforated female screw is attached to its lower end, having a perforated nipple-shaped termination, t which a rubber tube four feet long is connected, in order to convey the liquid fro the receiver to the canula which enters the bloodvessel; the mouth of the receive is closed by a rubber stopper, which prevents the escape of heat, and is perforate

---

[1] F. Esmarch.

[2] J. C. Hutchison.

Fig. 325.



Apparatus for injecting saline mixtures.

in the centre to admit a thermometer, which fits the opening tightly; when not in use, the thermometer is pushed well down into the receiver, to prevent it from being broken in handling; the canula has a nipple-shaped end, which is to be slipped into the distal end of the rubber tube, and is furnished with a stopcock; the receiver is surrounded by *a double jacket of India-rubber*, the walls of which are separated by a half-inch space for holding hot water; the water is introduced into the jacket through a tube projecting from the top, fitted with a nipple-end stopcock; an opening at the top of the jacket admits the receiver, and a smaller one at the bottom allows the metal cap to protrude; it has a narrow opening extending two-thirds of its length, to allow the operator to see the graduated marks on the receiver, and also a loop on the top for suspending the apparatus when in use. In using the apparatus drop the end of the rubber tube, to which the male screw belonging to the lower end of the receiver has been attached, into a vessel of hot water (150° to 200° F.) placed three or four feet above the patient, and attach the other end of the tube to the stopcock at the top of the jacket, the receiver having been previously put inside the jacket, because it cannot be introduced after the jacket has been filled; now compress the jacket with the hands to expel the air, which will be seen to rise in bubbles through the water; then remove the compression, and, placing the jacket lower than the surface of the water, a siphon is established, which fills it almost immediately. The jacket, when distended, holds ten ounces, and hugs the receiver closely, so that no air can get between them, which would prevent the heat from being imparted to the receiver. This method of filling the jacket is most convenient and rapid, and a larger amount of water can in this way be introduced than by pouring it into the opening at the top. The rubber tube is now detached from the stopcock at the top of the jacket, and is attached to the canula; and the other end of the tube is connected with the lower end of the receiver. The apparatus is warmed by filling it with hot water, which is allowed to run off before it is filled with the fluid which is to be injected. The receiver is then closed with the rubber stopper carrying the thermometer, and the apparatus is suspended or held, by an assistant, three or four feet above the vein which is to be opened. The vein is exposed by lifting a fold of skin transversely across it and dividing it with scissors or a bistoury, making the incision about three-fourths of an inch long. A probe is carried behind the vein, which is then picked up with forceps and opened, by a V-incision, with a delicate pair of scissors. Before doing this the stopcock of the canula should be opened and a small quantity of fluid allowed to escape, for the purpose of carrying off the bubbles of air which may have adhered to the walls of the tube. The rapidity with which the fluid is introduced can be regulated by the stopcock in the canula. After the canula is introduced it is fixed in position by the finger laid over the opening in the vein; no ligature is necessary to retain it in position.

The arterial injection of fluids has some advantages, viz: 1, the artery is readily found; 2, air accidentally introduced is not serious; 3, the heart is not so much disturbed by the pressure of too much fluid. The ulnar artery at the wrist may be selected. Expose it by incision, pass a ligature around and ligate it; divide it and insert the tube, which must be of small calibre, into the distal end; inject slowly. The fluid may be injected into the proximal end, and forced against the current until it reaches a bifurcation when it will enter the general circulation, but it is better to inject with the current.

Intra-venous injection of milk[1] is now recognized as a perfectly feasible and legitimate procedure, not only after hemorrhage, but in disorders which greatly depreciate the blood, as cholera, pernicious anæmia, typhoid fever; it is infinitely easier than transfusion, and any one at all familiar with surgical operations may practise it without fear of great difficulty or failure; the instrument required is a glass funnel with a rubber tube attached to it, ending in a very small canula; the milk should be removed from a healthy cow within a few minutes of its injection, and may be received into a warm pitcher covered with carbolized gauze, through which it is strained; open the median basilic or cephalic vein by a V-incision (Fig. 324), introduce the canula, and allow the milk to flow in; not more than eight ounces should be injected at once.[2] It is commonly followed by a chill as in transfusion, and rapid and marked rise of temperature, then all subsides and great improvement shows itself in the patient's condition.

IV. THE CAPILLARIES.

Local blood-letting is the withdrawal of blood from the capillaries of a part to relieve the congestion of organs or tissues. The seat of operation must, therefore, be selected with great care to obtain its full benefit. The exact area of arterial and venous distribution must be made out in each case, and blood should be taken at that point where the vessels are most nearly and readily reached; as the mastoid process, for the sinuses, in congestion of the eye, ear, or base of the brain; the angle of the jaw for the veins of the tonsils and pharynx in tonsillitic and pharyngeal inflammation; the thyroid body for the plexus of veins in congestions of the face, neck, and heart; the intercostal spaces for the arteries and veins in pleurisy; the third, fourth, and fifth left intercostal spaces for the internal mammary vein in pericarditis; the abdominal wall in peritonitis; the anus for the portal veins in inflammation of the viscera of the abdomen; the spermatic cord for orchitis; the regions of the joints for arthritis; the surface of limbs for periostitis.

[1] E. M. Hoader.

[2] T. G. Thomas.

Leeching is local bloodletting by the application of leeches; a good leech is estimated to draw ʒij, and ℥ss more will flow if fomentations are employed. Select active, healthy, Swedish leeches, and remove them from the water an hour before their application; cleanse the part to be leeched of all irritating matter, and hairs, and smear the surface with milk; place the leeches in a leech-glass, or in a tumbler or similar vessel, and invert it upon the part; if it is desirable to apply a leech accurately to a limited space, as in the angle of the eye, the internal part of the nose, mouth, vagina, a leech-glass, or tube made of cardboard or similar material, should be used to hold the leech and fix its attachment; avoid the upper eyelid and require the recumbent position for some time to prevent ecchymosis of parts about the eye; use the speculum in applying leeches to the os uteri, and bring the neck well into its cavity; plug the os with a pledget of lint to prevent the escape of a leech into the uterus; if the leech does not drop after being filled, apply salt to the body. To promote the flow from leech-bites apply warm moist dressings, as wet flannel cloths, or poultices; to arrest bleeding, apply a dry cloth, sponge, or picked lint, with pressure, or touch the bite with nit. arg. or persulph. ferri; in extreme cases pass a threaded needle through the cellular tissue under the bite and wind the thread firmly around under the needle.

The artificial leech is a tube one-eighth of an inch in diameter, having a cutting edge at one extremity (Fig. 326); it is wound up by the button, *a*; pressure at *d* releases the spring, and the cutting edge, *c*, cuts circularly to the requisite depth as fixed by *b*; to this cut apply a light glass tube (Fig. 327) from which the air is expelled by a few drops of ether poured into it, and then immersed as far as the mouth in hot water until the ether boils briskly. Each tube will draw about two ounces of blood; for uterine practice they are made long enough to be applied through a speculum.

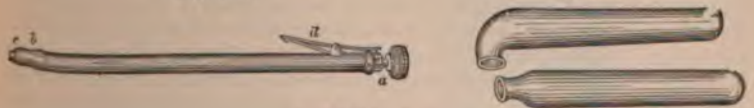


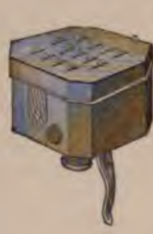
Fig. 326. Fig. 327.

Artificial leeches.

Scarification is a form of local blood-letting by incising the capillaries of the inflamed part, as in inflammation of the skin, the subcutaneous connective tissue, the tongue, the conjunctivæ. Select a sharp lancet or knife, and make incisions on the part of greater or less length and depth, according to the seat and extent of the congestion; fomentations will continue the flow of blood; if the bleeding is too free or long continued, use lint and pressure, if necessary, externally; and persulph. ferri, if the incisions are in cavities.

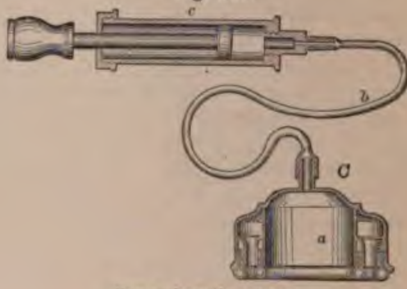
Cupping is a method of abstracting or withdrawing blood from an inflamed part by creating a vacuum in a vessel applied to the neighboring integument, with or without incisions; the former is wet, the latter dry, cupping. Wet cupping requires the scarificator, the cup, and spirit-lamp. The scarificator (Fig. 328) has a number of lancets whose protrusion beyond the face of the case is adjustable; these are set in a retracted position, and simultaneously discharged by a pull on the catch. The cup is a small glass or metallic cup, having a smooth mouth. Apply the scarificator in wet cupping; moisten the internal surface of the cup with alcohol, and by means of a wisp of paper or rag, wet with alcohol, on a stick, set fire to the alcohol in the cup, which should be instantly inverted over the scarifications on the place selected; the vacuum created by the burning alcohol causes the integument to rise in the cup, and thus the blood is forced out of the capillaries in wet, and stagnates in dry, cupping. The cup may have a suction-pump attached (Fig. 329); the receiver, *a*, is connected by a flexible pipe, *b*, with the nozzle of an ordinary syringe, *c*; the sides of the concentric chamber afford an extended bearing for the cup, and prevent its being driven into the integument by the pressure of the atmosphere. The cupping apparatus may have a lip attached to the glass cylinder suitable for application to the skin, or to the nipple when used as a breast pump (Fig. 330); a central rod, *a*, has a disk with lancets which act as scarifiers, and the air is exhausted from the cylinder by means of a piston in the tube, *b*, attached; the air-pump may be used as a syringe when detached from *c*, the blood receiver. In a very portable cupping-instrument (Fig. 331) the glass has an elastic bulb, *b*, by which the partial exhaustion is effected, and has also an adjustable disk provided with puncturing points to lance or irritate.

Fig. 328.



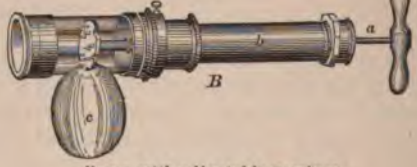
Scarificator.

Fig. 329.



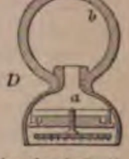
Cup and suction pump.

Fig. 330.



Pump with adjustable receiver.

Fig. 331.



An elastic bulb.

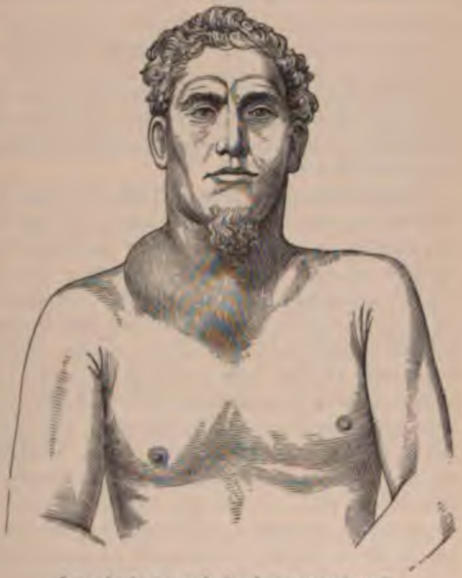
V. THE LYMPHATIC SYSTEM.

Obstruction of the lymphatics, lymphangiectasis, may be followed by dilatation and hypertrophy of the vessels beyond the seat of obstruction. When caused by parasitic obstruction and inflammation there is a cutaneous and subcutaneous hyperplasia, known as elephantiasis. These tumor-like swellings occur in the scrotum, the labia pudendi, in the region of the groin and breast; if congenital, they appear on the lip, macrocheilia, or on the tongue, macroglossa.[1] When accessible, as on the genital organs, the lip, or tongue, they must be removed by incision and dissection. In other positions the tumor may be diminished by position and pressure.

Lymphomata are tumor-like enlargements of the gland due to chronic inflammation. There are four forms: 1. Small-celled hyperplasia, with a tendency to caseation or suppuration, scrofulous lymphadenitis. 2. Large-celled indurative hyperplasia. 3. Reticular indurative hyperplasia. 4. Tuberculous enlargement.[1] The suppurating gland, as a bubo, scrofulous gland of the neck, should be opened, its contents carefully scraped out with the spoon, the cavity thoroughly cleansed with bichloride solution, 1-2000, a drain inserted, and iodoform dressings applied. The indurated and tuberculous glands should be early dissected out, the capsule of the gland being removed.

Lymphadenomata (Fig. 332) are non-inflammatory growths of the glands, and may be soft or hard. The first variety is marked by its soft and almost fluctuating feeling; it may involve but one gland, or it may appear in a group. They may not affect the blood. Hodgkin's disease, or the white corpuscles, may be increased, leukæmic lymphadenoma. The second variety occurs as a primary growth, most frequently in the superficial glands; other glands soon become involved, and they appear as firm, tough, elastic, or hardened knots, forming dense clusters. The treatment of these growths depends upon their location and condition; if they are harmless, or if the patient is feeble, they should not be disturbed; if, however, they appear as a single group, and are a source of annoyance, or undue pressure on other parts or organs, they may be removed. The dissection must be carefully conducted.

Fig. 332.



Lymphadenoma of glands at root of neck.

---

[1] E. Zeigler.

V.

THE NERVOUS SYSTEM.

THE BRAIN; THE SPINAL CORD; THE NERVES.

CHAPTER XXVII.

INJURIES AND DISEASES OF THE SKULL AND BRAIN.

INCLOSED within the skull and the vertebral canal, the cerebrospinal axis is protected by the bony walls of those two cavities; it is surrounded by (1) a dense fibrous membrane, the dura mater, placed most superficially; (2) a serous membrane, the arachnoid; (3) a highly vascular membrane, the pia mater; these two parts, the encephalon and spinal cord, are continuous structures.[1]

I. INJURIES OF THE SKULL.

Injuries of the bones of the cranium derive their importance from the liability of the brain to be involved directly or indirectly by the accident. The injuries of the skull which most frequently implicate the brain are as follows:—

Contusions of the skull may result in (1) rupture of the blood-vessels between the pericranium and bone, with an effusion of blood; (2) rupture of vessels running between the dura mater and the inner surface of the skull; (3) bruising or rupture of the veins of the diploë, or crushing of its cancellous tissue. The exact extent of the injury cannot be determined by the immediate symptoms, but as the inflammation which follows slight injuries may penetrate to the coverings of the brain, the treatment should from the first be rest, cold applications, simple diet, and laxatives. The symptoms of an inflammation penetrating through the bone usually appear not earlier than the sixth day nor later than three weeks. There are headache, rigors, giddiness, increased temperature, nausea and vomiting, contraction of pupils. As the meninges become involved these symptoms increase in severity, followed by delirium, chills and free sweating, rapid weak pulse, dilatation perhaps of one pupil, slight jaundice. The seat of injury swells, is tender, and has an elastic feeling. There may be hemispasm or hemiplegia. The treatment of the earlier stages should be actively antiphlogistic, with the free use of bromides. The later symptoms indicate the formation of pus, and the question arises as to its location. It will usually be at the seat of injury when the bruised part is puffy and tender, the headache extends from that point, the hemispasm is on the opposite side, and the pupil is dilated on the same side. There should be no hesitation about making an exploratory incision as follows: The necessary antiseptic preparations having been made, shave the hair from the surface to be incised, and irrigate the scalp with bichloride solution. With the knife, taken from the carbolic acid solution, make a free incision to the bone. If the pericranium is raised and the bone white, the trephine carbolized must be applied. When the bone is removed, if no pus is found between the dura mater and bone, and the dura mater does not protrude into the opening, the wound should be sprinkled with iodoform and lightly dressed with iodoform pads. If the dura mater bulges into the wound, it should be punctured with a carbolized exploring-needle, and if pus or serum is found it should be evacuated.

---

[1] Quain's Anatomy.

If the dura mater does not press into the wound, it is still possible that an abscess may be forming more deeply which will rapidly point toward the opening, and, hence, it is well to leave the wound open with antiseptic dressings, and watch for the indications of an abscess. If the dura mater finally bulge into the wound, it should be punctured as above. If the indications all point to the collection of pus at the seat of injury, and it is not apparent after trephining, it is proper to explore deeply with a fine carbolized aspirating needle. If pus is found at any point or depth, it must be evacuated and antiseptic dressings applied.

Fissure of the skull accompanying scalp wound, but unattended by brain disturbance after subsidence of the shock, is not infrequent; fissure may be detected through the wound, though there is no displacement; or there may be inequality of the line of fracture, indicating some depression, without brain injury. These cases require the treatment for concussion, with long-continued abstinence from any and every source of excitement.

Fractures and fissures[1] which extend to the base of the skull are diagnosed with difficulty. Ecchymosis in the mastoid region, of the pharynx, or of the eye, is a rare and uncertain sign. Pharyngeal extravasation is most important. When ecchymosis appears first, some thirty-six hours after the injury, on the ocular conjunctiva, and spreads to the lids, it is pathognomonic of this form of fracture. Oozing of blood and serum from the ear is diagnostic of fracture of the petrous bone only when limpid fluid is supplied in abundance, and contains an excess of chloride of sodium. Paralysis of the facial and auditory nerves is only a suspicious symptom, and must be taken in connection with the other evidence, for it may result from inflammation or pressure. The treatment is long-continued rest, low diet, saline cathartics.

Fracture of the skull is of comparatively little importance, except so far as it is accompanied by, or entails as a sequence, mischief to the brain. It is held that in the majority of cranial fractures the inner table is more extensively shattered and splintered than the outer table,[1] and it is to this source of irritation that we may justly assign, in many cases, the dangerous inflammation which follows cranial fractures, and in other cases the remote nervous symptoms, as epileptic seizures, and grave forms of insanity. It is, therefore, of the first importance that the surgeon promptly take such measures, in every case of fracture of the skull, as will protect the patient from future complications. It is quite impossible to formulate exact rules of treatment which will be adapted to the conditions of every case; much must be left to the good judgment and discretion of the surgeon. But there are certain general principles which will serve as landmarks to guide to correct practice.

---

[1] F. Le G. Clark.

The operative treatment of fracture of the cranium should in general be decided according to the following rules;[1] conditions may exist in individual cases which will modify them :—

(*a*) **In closed fissured fractures** if there is, 1. No evident depression, no brain symptoms, no operation; 2. No evident depression, with brain symptoms, incise scalp and trephine; 3. With evident depression, no brain symptoms, incise scalp and possibly trephine; 4. With evident depression, with brain symptoms, incise scalp and trephine.

(*b*) **In closed comminuted fractures** if there is, 1. No evident depression, no brain symptoms, incise scalp and probably trephine; 2. No evident depression, with brain symptoms, incise scalp and trephine; 3. With evident depression, no brain symptoms, incise scalp and trephine; 4. With evident depression, with brain symptoms, incise scalp and trephine.

(*c*) **In open fissured fractures** if there is, 1. No evident depression, no brain symptoms, no operation, but treat wound; 2. No evident depression, with brain symptoms, trephine; 3. With evident depression, no brain symptoms, possibly trephine; 4. With evident depression, with brain symptoms, trephine.

(*d*) **In open comminuted fractures** if there is, 1. No evident depression, no brain symptoms, probably trephine; 2. No evident depression, with brain symptoms, trephine; 3. With evident depression, no brain symptoms, trephine; 4. With evident depression, with brain symptoms, trephine.

(*e*) **In punctured and gunshot fractures,** trephine in all cases and under all circumstances.

II. DISEASES OF THE SKULL.

Tumors occasionally form in the skull. The osseous and cartilaginous variety are most frequent, are easy of diagnosis, and are susceptible of complete removal. Cancerous and sarcomatous tumors are occasionally met with, and their removal has hitherto proved very fatal. With the use of antiseptic measures much better results have been obtained. All operative procedures for their removal should therefore be carefully protected by the usual antiseptic agents.

Extirpation of malignant tumors of the skull by antiseptic methods has resulted as follows: Of 15 cases, 13 recovered and 2 died; 3 were male, 10 females, 2 not given; the youngest was 19, the oldest 64, average 44 years old; in 8 the dura was cut into or cut away, in 4 the falx was cut, in 2 the longitudinal sinus was divided, in 2 brain tissue was removed, but in only one case was this complication followed by death; in 5 cases the bone removed was over 3 inches in breadth; 1 was myxoma, 2 carcinoma, 1 epithelioma, 2 cancroid, 2 mixed connective tissue, 7 sarcoma; in but 1 did recurrence take place before the healing of the wound, in 4 speedy recurrence followed.[1]

---

[1] J. B. Roberts.

III. INJURIES OF THE BRAIN.

Concussion,[2] or violent commotion of the brain, may cause slight and temporary effects, or may produce irreparable organic change in its structure without palpable laceration or contusion of any particular part. The symptoms are usually mixed with those due to other complicating injuries; so far as the symptoms of concussion may be isolated, the milder forms present the general indication of shock, manifested by giddiness, confusion of intellect, tottering gait, functional disturbance of the senses, sympathetic irritability of stomach, and fall of temperature. In fatal concussion, death occurs from shock rather than from direct injury to the brain. The treatment must always be directed with reference to the possible complication of fracture; perfect quiet is always necessary; if the shock is severe, stimulate the skin by frictions, warmth, mustard paste; apply ammonia to the nose, and if necessary give small doses of brandy; avoid too great reaction; when it occurs, moderate its effects upon the brain by shaving the head and applying ice; if no complications appear, continue rest and freedom from all mental disturbance for from one to four or five weeks, according to the severity of the shock.

Contusion, or bruising, of the brain[3] occurs in many cases of concussion; the blood may be found extravasated in circumscribed patches, or these spots may be disseminated throughout various parts of the cerebral mass; bruising is far more frequent on the under than the upper surfaces of the cerebrum and cerebellum, and seldom occurs in the pons or medulla oblongata; it is rarely limited to the region of injury; in fissure the bruised part is frequently far away, or opposite the seat of the blow. The lesion is marked by no characteristic signs; contusion may legitimately be inferred whenever the symptoms are severe after injury of the head. It is always a grave accident, chiefly from the liability to inflammation of the surrounding substance immediately or remotely. The treatment is prevention of inflammation, and in detail the same as is required in concussion.

Compression of the brain is that condition which exists when pressure is made on the cerebral mass to such an extent as to diminish or obliterate its functions. The symptoms of well-marked compression are as follows: The pulse has a slow and full beat; the pupils are fixed and generally dilated; voluntary movement and sensation are partially or entirely suspended; there is stertor; paralysis of the sphincters; the temperature, which is no measure of the amount of lesion of the brain, may fall to 94° F. or 93° F., and recovery follow.[3] The cause of the compression may be depressed bone, when the symptoms will immediately follow the injury; or extravasated blood, when the symptoms will gradually supervene; or, intracranial inflammation,[4] which may be followed by a collection of pus; or, finally, compression by bone, and extravasation of bloo within the brain from laceration, may coexist.[1] The precise seat o compression may be determined in cases of compound fracture wit depression, with the probe or finger, and also the exact amount o depressed bone may be defined. If there is no external injury, the special nerves paralyzed must be the guide to the point of pressure; but this symptom has only a general significance and value owing to the extent of internal injury which usually exists. If there is right hemiplegia, compression is usually on the left hemisphere; at what precise point it may now be possible to determine by the peculiarity of the paralysis.

---

[1] Med. News.

[2] F. Le G. Clark.

[3] P. Hewitt.

[4] J. B. Roberts.

There are no definite symptoms by which we can distinguish accurately between laceration of the brain, contusion of the brain, and the so-called compression of the brain.[2]

The treatment aims at the removal of the cause of compression. If the cause is unknown, and the seat of pressure cannot be satisfactorily made out, direct perfect quiet; apply cold to the head to prevent inflammation, and give saline cathartics to promote absorption; sustain the strength, and depend upon time for recovery. If there is depressed bone, or if there is evidence of extravasation of blood between the bone and dura mater at the seat of injury, proceed at once to trephine.

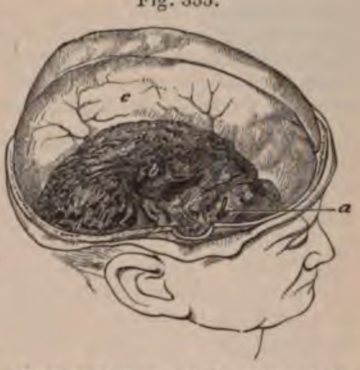
Wounds of the brain and membranes[2] may be punctured, cut, or lacerated; these lesions are not necessarily fatal, though as a rule they are; death may ensue without reaction, or after inflammation is developed. The symptoms, when unaccompanied by pressure, are frequently not developed until inflammation ensues, and therefore the diagnosis is naturally obscure; or the nature of the lesion may be overlooked until there are indications of brain disturbances, after an interval of three or four days, or longer. Examination with the finger or probe determines the nature, and partially the extent, of the injury. The treatment is designed to prevent inflammation and its consequences. The hair should be shaved, fragments of bone or foreign matters lodged in the wound removed, and, if necessary, the wound must be enlarged by the trephine; having thoroughly cleansed and disinfected the wound, bring the integuments together and retain them with adhesive or rubber plaster; apply ice-bladders; enjoin perfect quiet, with saline cathartics, and low diet. If inflammation follows, the brain is liable to protrude at the wound, creating a hernia cerebri, and abscess may form.

Intracranial hemorrhages[3] occur between the cranium and dura mater, in the cavity of the arachnoid, in the meshes of the pia mater, in the substance of the brain, and in the ventricles. Hemorrhage between the dura and cranium (subcranial extravasation) is not very unusual as an accompaniment of head injuries, because the branches of the large middle meningeal artery ramify over the inner surface of the parietal bone, which, from its position, so often bears the brunt of the vulnerating force. Indeed, the artery is sometimes, especially at the lower anterior angle of the bone, inclosed in a bony canal, so that fracture of the bone at that point almost insures the laceration of the artery (Fig. 333). The venous sinuses are also torn or wounded at times, and cause subcranial extravasation. In bleeding from the middle meningeal artery, the clot often causes pressure at the base of the skull, and therefore may, by pressure on the cavernous sinus and nerves going to the eye, cause on the side of injury protrusion of the ball and dilatation of the pupil, or wider dilatation than in the other eye; while the hemiplegia from cortical pressure will be on the opposite side. If a fissure exists, the blood may escape into the temporal fossa of the injured side and cause tumefaction there. Blood poured out in the meshes of the pia mater is usually associated with laceration of the brain, and spreads so widely over the surface of the convolutions, that it is impossible to locate the origin of the bleeding or to remove the distributed blood. The differential diagnosis between circumscribed hemorrhage within the arachnoid cavity and circumscribed hemorrhage between the dura and cranium is practically impossible, though it is said that marked inequality of the pupils and marked hemiplegia are less noticeable in arachnoid extravasation than in subcranial extravasation.

---

[1] T. Holmes. [2] F. Le G. Clark. [3] J. B. Roberts.

Fig. 333.



Drawing showing clot (*b*) external to the dura mater (*c*) from laceration of the middle meningeal artery (*a*) following a fracture.[2]

The diagnosis[1] of traumatic subcranial hemorrhage, and indeed, in a surgical sense, the same may be said of arachnoid hemorrhage also, centres upon the absence of the characteristic symptoms of laceration, and upon the fact that the group of symptoms commonly called compression of the brain occur not immediately after the injury, as in laceration of the brain or hemorrhages into the ventricles or brain substance, but later, that is, after the interval of a few minutes or hours.

For example,[1] a man is struck on the head and falls stunned, but soon recovers consciousness, though subsequently he becomes comatose and paralyzed on the side opposite the injury. Here the presumption of a subcranial or arachnoid hemorrhage having occurred, as soon as reaction has sent enough blood to the head to distend the torn vessel, is very great. This period of immunity from head symptoms after traumatism is sufficient to justify operative search, when an injury or such symptoms as coma, dilated pupil, hemiplegia, monoplegia, or monospasm, sufficiently localize the effusion; or, if the symptoms are increasing or are of sufficient severity, to point to the probability of active encephalitis. Apoplexy, drunkenness, opium poisoning, uræmic coma, and intracranial hemorrhage are often to be differentiated in cases without history. The problem is frequently difficult.

[1] J. B. Roberts.

[2] T. Bryant.

The question of operative treatment in these cases must now be considered in a new light. Formerly the tendency was to deter surgeons from operating in intracranial extravasations, unless the certainty of diagnosis was great.

For example, it was formerly contended[1] that the only case in which such a procedure is really warrantable, is where the extravasation is associated with, or dependent upon, fracture of the skull, complicated with depression, or serious injury of the soft parts, or where the fracture is situated directly over the course of the middle meningeal artery.

This advice is too restrictive;[2] gradually increasing brain symptoms after head injury, especially if there has been a period of return to consciousness after shock of traumatism, suggest the occurrence of intracranial bleeding from meningeal vessels, even when no fracture or depression of bone is detectable; operation is then especially indicated, if the localizing symptoms point to no other region of the cortex, and if symptoms do not render cerebral laceration quite probable. A very short interval indicates rapidly flowing hemorrhage and demands early operation, with probably ligation of the middle meningeal artery or one of its large branches, or ligation or compression of a sinus. It must be remembered also that compression symptoms, coming on immediately or quite soon after depressed cranial fracture, are very often due to the subcranial clot rather than the depressed bone. Removal or elevation of bone is often needed more for liberation of blood-clot and control of hemorrhage than for deformity in the bony outline. Rapid hemorrhage will probably be from the middle meningeal artery, and therefore a large trephine should be put over the anterior inferior angle of the parietal bone, and the squamous portion of the temporal bone just below this angle, unless the localizing symptoms direct to some other point.[2]

Inspection of the skull will show that the two large branches of this artery, as they ascend to distribute branches to the lateral region of the cranium, can both be uncovered by a large trephine applied at this point. This point is situated about an inch and a half behind the external angular process of the frontal bone and one inch above the zygoma, or an inch and a half directly above the condyle of the jaw.[2]

The bleeding vessel when found may be ligated or twisted, or the bony canal plugged with a piece of stick or wax, or the actual cautery applied by means of a red-hot needle. An operation is contra-indicated in cases of intracranial bleeding that do not present the symptoms which are believed to be produced by accumulation of blood in either the cavity of the arachnoid or the space between the skull and dura mater.[2]

Shot wounds of the brain, especially when the missile is lodged within the cranium, are among the most fatal accidents to this organ. Suppuration rapidly follows, with destruction of brain tissue, and frequently pyæmia terminates the case. Even if the missile is found and removed, the inflammation generally occurs with fatal results. In a single case of shot wound of the brain, and removal of the ball, followed by recovery, the surgeon attributes the result to neither skill nor attention, but to the will of Providence alone.[1] The failure of treatment has been due to the additional injuries inflicted upon the brain by the efforts to remove the ball, and the inability of the surgeon to control the inflammation which necessarily followed this twofold damage done to brain tissue. Experience proves that skill and attention, with the aid of antiseptic agents, may cure even these unpromising accidents. The skill consists in the removal of the missile without further injury of the brain, and the attention appears in the subsequent care of the wound. One of the chief sources of danger in these wounds, after the removal of the foreign body is the accumulation of the discharges due to the failure to secure proper drainage. It cannot be too emphatically asserted that drainage is more essential in wounds of the brain than in wounds of other structures.[2] The principles which underlie the successful treatment of shot injuries of the brain, which admit of cure, may be stated as follows, viz: 1. The removal of the foreign body without farther injury to the brain; 2. Securing good drainage; 3. Preventing inflammation. The first two conditions are most effectually secured by making a counter opening in the skull. As a rule, a ball, after penetrating the skull, passes directly through the brain tissue to the opposite side of the cranial vault, and rebounds to an extent depending upon its velocity. It is usually found in the brain substances near the point where it struck the skull. It is apparent that, even if the ball can be readily removed by the wound of entrance, the escape of the discharges of the wound, which at first consist largely of broken-down brain matter, cannot be sufficiently free to preserve the wound from infection. But it now often happens that the ball cannot be removed by the wound of entrance without destructive probing and searching for it. A counter opening in the skull, therefore, becomes a necessity which has hitherto been too rarely practised. The third element in the treatment, the prevention of inflammation, is found in the antiseptic appliances to the wound. Not only can the external wound be maintained in an aseptic state, but the track of the wound through the brain can be kept in a state of absolute cleanliness by means of the drain, which may be horsehair or a tube. The method of applying these principles has been illustrated in a case in which skill and attention evidently secured a successful result.

---

[1] S. D. Gross.

[2] J. B. Roberts.

The operator,[3] in a case of pistol-shot wound of the brain, the ball entering the centre of the forehead, first freely enlarged the wound in the skull, arrested hemorrhage from the longitudinal sinus and an artery of the pia mater. The patient's head was now placed in such a position that the presumed track of the ball to be probed was perpendicular to the horizon, that the delicacy of touch might not be obscured by the effort to direct the probe out of a perpendicular. A perfectly straight, common Nélaton probe was selected, which was passed to a depth of about six inches, where a soft resistance was felt, but no effort was made to overcome it. The depth to which the probe was passed established the inference that the bullet had passed through the hemisphere and struck the opposite side of the skull. The probe was left standing in the brain, and, from the direction of the portion protruding from the forehead, viewing the head at the side and vertex, the point upon the scalp was noted at which the probe would emerge if projected through the head. Having observed the shape of the skull at this place, a cross was marked upon the scalp with the scalpel at a point three-quarters of an inch lower down, toward the base of the skull, in the supposed plane of the path of the ball. The probe was withdrawn, the wound dusted with iodoform, and the flaps temporarily drawn together. The trephine was now applied at the point marked on the other side of the head, and a disk of bone five-eighths of an inch in diameter removed; the dura mater was healthy; the brain did not seem to beat with normal force, but this was doubtful; the dura mater seemed to cover a dark background; catching the membrane with a uterine tenaculum, and lifting it from the surface of the brain, it was slit for a quarter of an inch in a direction toward the supposed point of emergence of the bullet; a small quantity of dark fluid blood oozed from the opening when the brain was pressed upon. The trephine hole was enlarged with a *rongeur* forceps toward the assumed opening of emergence of the bullet. With the point of the index-finger a resistance in the brain at the depth of about half an inch was felt; enlarging the opening in the dura mater more brain-mater appeared, together with a semi-fluid clot. The probe was introduced through the opening in a direction towards the resistance felt with the finger; after passing about one inch, it came in contact with the bullet at a depth of about half an inch below the pia mater. By the aid of a slender-bladed anatomical forceps, the battered bullet, weighing forty-two grains, was extracted. Thus was the bullet tracked by means of the probe throughout its whole course to its place of lodgment and removed. The patient's head having been placed in the same position as during the first trial, the Nélaton probe was again gently passed through the wound through the brain, the only obstruction to its passage being the dura mater, which was incised. A small-sized rubber tube, instead of catgut, was used after for a drain, having been made aseptic in a two and a half per cent. solution of carbolic acid, and was further washed in the bichloride solution. One end of the tube was slipped over the handle of the probe and tied in place with carbolized silk. The probe was then drawn through the brain in the direction taken by the bullet. The tube, as it was drawn through the wound, became filled with brain detritus and blood. No effort was made to clear its calibre by injecting the antiseptic solution through it. The blood in the tube could be seen pulsating. The projecting ends were cut off to within an inch and a half of the skull and transfixed with safety pins. At both the anterior and posterior wounds the flaps were brought partly together by sutures at their bases, room being left for the ends of the tube, the wounds were dusted with iodoform, and covered with Lister's protective silk, which was in turn dusted with iodoform. Over the protective, iodoform gauze was loosely packed, and over all a combined dressing of borated cotton held between layers of carbolized gauze was applied. The space between the brows having been filled with borated cotton, the eyes were covered in by the bandages which secured the dressings. The operation was completed in about four hours from its commencement, the greater portion of the time having been spent in stopping the cerebral hemorrhage. The patient recovered, though a hernia cerebri developed.

---

[1] B. Howard.

[2] J. B. Roberts.

[3] W. F. Fluhrer.

It is recommended[1] to make a counter-opening in the skull even when the ball is lodged in the interior of the brain. In such cases the probe is to be passed through the wound of entrance down to the ball, and then in a straight line through the brain to the opposite wall of the skull where the trephine should be applied, the ball removed, and complete drainage established.

Epilepsy and insanity, following injury, are frequently cured by the removal of the cranial wall at the site of traumatism. The exciting cause is found to be some local change due to the injury, as an internal spicule, or osteophyte from depressed or chronically inflamed bone, penetrating or pressing upon the membranes; thickened bone; pathological changes in the membranes themselves; the existence of a sequestrum of necrotic bone; depressed and neuralgic cicatrices of the soft parts, and similar kinds of irritation.[1] Insanity following injuries of the head is probably due, in most instances, to the same conditions. It is very truly stated[2] that the prognosis is bad in a considerable proportion of cases of traumatic insanity, but it is equally true that a certain limited number may be cured, or, at least, greatly improved by timely surgical interference; obviously, the cases which are most likely to be benefited by operative procedure are those with depression of the skull, in which the location of the brain lesion can be determined with a reasonable degree of accuracy, the site of the lesion being such as to render the use of the trephine anatomically admissible.

---

[1] W. F. Fluhrer.

The following rules should govern the operator:[3] 1. The operation should be done as early as possible, because the long-continued irritation and interference with the healthy nutrition of the brain and nervous system will often beget a permanent impression, which will remain after the part of irritating bone has been removed. 2. It should be thorough and complete, for if all of the offending part is not removed, no benefit will accrue. 3. The operation should be carefully and cautiously done, as no one can foretell the changes that may have taken place in the parts around the injured bone, and a rude operation may cause irreparable mischief which might have been avoided by one carefully planned and skilfully executed.

The operation should be antiseptic, and the dressings should secure good drainage, and complete protection from all sources of irritation.

III. DISEASES OF THE BRAIN.

Inflammation within the cranium[4] may follow any injury to the head; the brain alone may be involved, or the membranes, and even the bone. Inflammatory softening is rarely met with in the central white portions of the brain, but the cortical substance is frequently inflamed, as the result of injury to the bone, and meningitis, which supervenes after concussion; the inflamed gray matter becomes of a dark-red hue, is swollen and soft; effusion takes place in the pia mater, and the gray matter becomes of a darker color and diffluent; this softening is frequently very extensive, the white matter remaining unaffected. There are two kinds of traumatic inflammation of the membranes; one commences in the dura mater and almost always reaches the free surfaces of the arachnoid; the other, commencing in the pia mater, seldom passes beyond this membrane unless the inflammation is very severe. When the inflammation spreads inwards from an injury of bone or of its coverings, its progress may be traced, as it were, layer by layer, from the outer parts down to the brain, involving first the dura mater, then the parietal and visceral arachnoid, the pia mater, and ultimately the cortical substance of the brain. In suppuration of the bone the outer surface of the dura mater is covered with lymph or pus, its tissue becomes infiltrated, and sloughing may follow; the mischief is generally confined to that part of the membrane directly under the diseased bone, but it may spread along the cellular tissue around the meningeal arteries, and thus reach even to the base of the skull. When this inflammation reaches the arachnoid it becomes widespread, and the cavity of this membrane becomes filled with a puriform exudation of a yellowish-green color, extending sometimes over one and occasionally over both hemispheres, but not to the base. From the arachnoid the inflammation spreads to the pia mater, where it is followed by a similar exudation. The cortical substance corresponding to the inflamed pia mater is often of a dark leaden hue, soft and easily torn; the white substance is simply congested. The symptoms of traumatic intercranial inflammation are progressive, as follows: (1) Pain in the head, more or less intense, confined to the seat of injury or spreading over the whole head, fever, contraction of pupils, intolerance of light and sound; (2) disturbance of the brain-functions, restlessness, constant tossing about, convulsions, delirium; (3) drowsiness, oscillation and dilatation of pupils, twitchings and spasms of muscles, coma, relaxation of sphincters, paralysis; (4) rigors, indicative of suppuration. The portion of the cortical substance involved can be determined only by careful attention to the groups of muscles involved in spasm or paralysis. The treatment should be decided upon after examining the different viscera, especially the kidneys; in general, secure rest and quiet in a dark room; shave the head, elevate it, and apply ice or the cold douche; give repeatedly saline purgatives; venesection is very rarely required, but leeching the temples is often useful; blisters may be applied in late stages; bromide of potassa in twenty to forty grain doses may be necessary to secure quiet and sleep; opium should not be given unless other anodynes fail. If the symptoms sufficiently indicate a collection of pus accessible to the trephine, this operation should be performed.

---

[1] J. B. Roberts.

[2] C. F. Mac Donald.

[3] W. T. Briggs.

[4] P. Hewett.

Abscess of the brain follows injury, either from an inflammation excited by the increased vascularity of the tissues and the absence of any escape for disorganized tissues and the superfluous products of reparative process, or by the penetration of the inflammation from the external injury through the intervening tissues; in the former case the abscess forms in the interior of the brain, and in the latter between the bone and dura mater.[1] The formation of pus is usually, but not invariably, indicated by a well-marked shivering fit in intercranial inflammation; coma or compression may not follow, as brain abscess is usually devoid of any new element in its ingredients,[1] but if the pus is between the bone and dura mater, symptoms of compression generally appear.

The symptoms of abscess are necessarily variable, as they must depend upon the particular part of the brain-tissue involved, and the conditions preceding its formation. If it supervene upon a meningitis the pulse and temperature may range high, the latter being above 100°; but if it form in the substance of the brain without meningitis, the pulse falls, and the temperature is subnormal. If it is located in the middle third of the brain, there will be spasm or paralysis, while these symptoms may be absent if it is in the frontal position. In general the following symptoms will appear: headache, vomiting, coma, with more or less complete paralysis, usually of the opposite, more rarely of the corresponding side of the body, spasms.[1]

---

[1] F. Le G. Clark.

The location of the abscess may occasionally be fixed by observing the muscles affected by spasm or paralysis. The treatment when abscess is declared, as by symptoms of compression, is trephining; the point of operation should be the seat of previous injury, which may be marked by a puffy swelling of the scalp; when the bone is perforated, if pus is not found, and the dura mater bulges into the hole, giving evidence of the existence of pus beneath membrane, divide the dura mater; if pus is still not discovered and there is good reason for believing that a cerebral abscess exists under, or in the neighborhood of, the part perforated, systematic punctures[1] of the brain should be made in different directions with a view to explore the entire area. The hypodermic needle should be four inches long,[1] and at the point may be rounded instead of cutting, to avoid wounding bloodvessels.[2]

The following suggestions[1] will prove useful: A well disinfected needle is pushed in straight in a certain direction for almost half an inch or an inch; the piston of the syringe is then drawn a little; if no pus follows, the needle is pushed in half an inch further, and the piston is again drawn a little. The depth to which it will be permissible finally to push the needle will, of course, vary with the situation of the trephine opening, and the direction of the puncture. In this respect the surgeon will be guided by the anatomy of the brain. The punctures are to be executed at interstices of half an inch or an inch, the utmost care being observed to push the needle in straight, and to avoid all lateral movements. If, after a reasonable number of punctures, no pus is drawn, the operator may feel convinced that no abscess is present.

An abscess having been found, it should be opened, not with a knife, but with a blunt instrument, as a pair of forceps, carried along the needle as a guide. The cavity should be drained with a tube or horsehair, unless the flow of pus is free, and it may be washed out with a solution of boracic acid, or with carbolic acid if the former fail to relieve.

The drain-tube, as a foreign substance, would seem to add to the danger of acute œdema of the brain, which is so fatal, but it has now been used several times with good results; it should be thoroughly aseptic.

Hernia cerebri is the protrusion of brain matter, or the products of inflammation, through openings in the bone and meninges; it may follow fractures or trephining. It is mainly due to inflammation of the brain and to the effusion of serum and pus; the cerebral substance around the place of protrusion is congested, swollen, œdematous, and soft; abscesses frequently form in the hemisphere involved, and large effusions of various kinds fill the ventricles; the mass rises out of the opening like a mushroom, and often partially sloughs away. It may terminate in recovery, gradually wasting away, but in the majority of cases the patient sinks sooner or later. The treatment is that of an inflammation; remove all sources of irritation; secure rest and quiet; preserve perfect cleanliness by irrigation with bichloride solutions; dust the dry surface with iodoform and apply idioform dressings; redress the wound with great care to preserve the utmost cleanliness with antiseptic solutions. Under this method of treatment much better results are obtained than formerly. Severe pressure, caustics, and the knife are injurious.

---

[1] C. Fenger.

[2] Renz.

Hydrocephalus is an effusion of fluid internal or external to the ventricles, and may be congenital or acquired; the former being due to malformation, the latter to meningeal inflammations. In the congenital form, well marked, the effusion is into the ventricles; as the fluid increases the pressure from within gradually unfolds the convolutions, and thus expands the cranial arch; the base may undergo little change, but the frontal, parietal, and occipital bones are expanded in all directions, and become much thinner; the hemispheres are spread out in thin laminæ on either side, decreasing in thickness from the base to the vertex; the membranes do not usually undergo any alteration except such as arise from distension. If the eyes have a persistent and characteristic downward direction, it is due to a change in the orbital plates of the frontal bone. In the acquired form, the effusion is over the surface of the brain, in the subarachnoid spaces, or in the lateral ventricles; it generally comes on after consolidation of the bones, but may appear very early and assume the conditions of the congenital variety. Operative interference is of two kinds, namely, compression and tapping. They are opposite measures, and adapted to different and opposite conditions of the brain; the one repairs defect of pressure, the other relieves its excess; either expedient may suffice alone; both may be profitably employed in the same case in succession, according to varying circumstances; if the walls of the head are tight and firm, the trocar should precede the bandage; if lax and movable, compression should be cautiously tried, and followed, if need be, by the puncture.[1]

Compression should be employed as follows: Cut strips of adhesive or rubber plaster one-third of an inch in width; apply first one strip from each mastoid process to the outer part of the orbit on the opposite side; then from the back of the neck along the longitudinal sinus to the root of the nose; next over the whole head so that the strips cross each other at the vertex; finally, pass a long strip three times around the head, just above the ears, eyebrows, and below the occipital protuberance; avoid making the dressing too tight, lest convulsions should be excited; if the health is good and the cap is tolerated it must be continued, but if the increase of fluid threatens convulsions it must be loosened or removed in a few days. If tapping is necessary, proceed as follows: Select a small aspirating needle, or a small trocar, if the aspirator is not used; holding it perpendicularly, insert it at the edge of the anterior fontanelle to avoid the longitudinal sinus and the large veins emptying into it; withdraw the fluid very slowly, meantime maintaining moderate external compression by the hands of an assistant, or a bandage; not more than two or three ounces should be drawn at once, and if the pulse becomes weak, or the dilated pupils contract, or there are signs of convulsions, the needle or canula must be withdrawn, and the puncture hermetically closed. To maintain proper compression, a cap may be in readiness, made of sheet caoutchouc, and perforated with small holes.

Meningocele[2] consists of a protrusion of the meninges of the brain by an accumulation of fluid within the cranium of the new-born

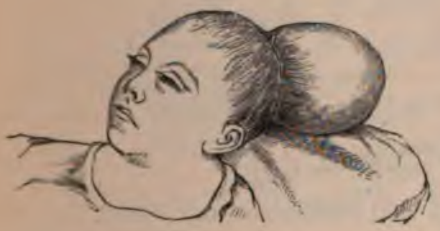
---

[1] T. Watson.

[2] T. Holmes.

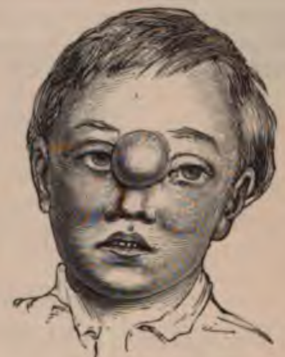
infant; the tumor appears at one of the fœtal openings of the bones, and is caused by a preëxisting hydrocephalus; the ordinary situation is in the occipital region (Fig. 334), and the tumor protrudes through the expanded portion of the occipital bone, behind the foramen magnum, and in the middle line; occasionally this tumor appears at other points, especially at either fontanelle, and at the root of the nose (Fig. 335). It has been found at the sides of the skull where the bones are joined, at the inner angle of the orbit, above the orbital arch, in the temporal region, at the base of the skull communicating with the deep parts of the face. The tumor may be a single sac, or have numerous septa; it may be sessile or have a pedicle; it may be translucent like a hydrocele and enlarge when the child cries; or be reducible. The nature of the tumor is recognized by these appearances, and by its being congenital. The dangers of interference with these tumors lies in their relations to the meninges and the brain. In treatment avoid all irritating external applications. As a rule, nothing ought to be done but support the tumor and make gentle pressure with a bandage, or cap, protected with cotton-wool to prevent ulceration, as gutta-percha lined with layers of wadding which can be gradually increased in number as the tumor yields to pressure; if it is on the increase without other symptoms, repeated puncture may be tried, the air being excluded; if the tumor has a pedicle, iodine may be injected, using ℥ij with equal parts of water, after some of the fluid has been removed. Excision should be practised when the communication of the tumor with the brain is obliterated; if the operation is undertaken while there is still an opening into the cerebral cavity, the pedicle should be embraced by a clamp, and flaps should be made so as to perfectly cover the wound when united by the continuous suture. Antiseptic irrigation should be continued while the suture is being applied, and iodoform dressing should be used. The clamp should be retained twenty-four hours or more to preserve proper contact of the opposed surfaces.

Fig. 334.



Meningocele.

Fig. 335.



Meningocele at the root of nose.

Encephalocele resembles meningocele, but its contents consist of a protruding portion of brain, or of brain and dropsical membranes; it appears at the various openings of the skull, and may be sessile or pedunculated; it is recognized as a congenital tumor, often pulsating, generally small and flat; it is most difficult of diagnosis when seated at the root of the nose, in the course of the frontal suture, or near one of the angles of the orbit, as it resembles sebaceous or other tumors; in cases of doubt, the effects of pressure upon the growth must be carefully noted, and the examination should be several times repeated; it is justifiable to use an exploring needle. The treatment is that of meningocele.

CHAPTER XXVIII.

TREPHINING THE SKULL AND EXPLORING THE BRAIN.

The operation of trephining has recently assumed a new and most important position in the surgery of the brain. This change is due to two causes, viz: 1. The means which antisepsis affords of protecting the wound from the effects of septic poisons; and 2. The knowledge which we now have of the localization of the centres of functions of the brain.[1] Antisepsis relieves the operation of the dangers of suppuration, whether of the soft tissues or of the bone, and also enables the surgeon to arrest that process if it is in progress at the time of trephining; while a knowledge of the location of the centres, on which depend the functions of the brain, gives precision in the selection of the place where the operation must be performed. The antiseptic methods have been fully discussed. As the localization of brain functions has been raised from the level of an hypothesis to that of a definitely ascertained fact,[2] the surgeon must familiarize himself with the latest teachings of neurological science in regard to the location of functional brain centres.

If any of the cerebral functions are with certainty recognized as located in definite convolutions and regions of the cortex of the cerebral hemispheres, and if it has been demonstrated that perforation of the skull and incision of the membranes will at times prevent the destruction of life by intracranial inflammation, abscess, or tumor, it follows that one who assumes to be competent to relieve disease by operative measures must make cerebral localization a subject of study.[3]

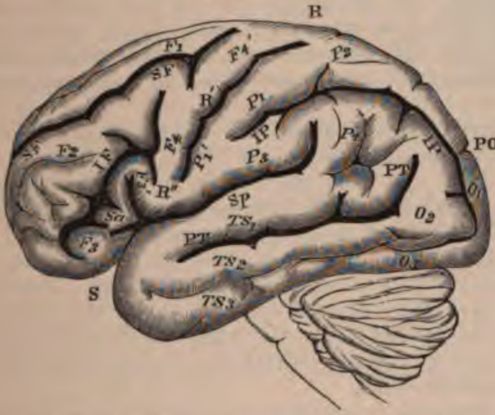
I. CEREBRAL ANATOMY.

In order to apply the facts of localization of function, it is necessary to understand certain peculiarities of cerebral anatomy. As the guides to the functional centres are the fissures and convolutions of the brain, the first step in the inquiry is to learn the present nomenclature and the precise location of these anatomical parts. These have been arranged and classified (Fig. 336).

---

[1] Broca; Hitzig; Ferrier. [2] M. A. Starr. [3] J. B. Roberts.

Fig. 336.



The fissures are as follows:[1] *S*. Fissure of Sylvius, and *Sa*, its anterior, and *Sp*, its posterior limb; *R*. Fissure of Rolando; *PO*. Parieto-occipital fissure; *IP*. Intra-parietal fissure; *PT*. Parallel fissure; *SF*. Superior frontal sulcus; *IF*. Inferior frontal sulcus. The convolutions are as follows: *F1, F2, F3*. Superior, middle, and inferior frontal convolutions; *P2*. Superior parietal convolutions; *P3*. Supra-marginal lobule; *P4*. Angular convolution; *TS1, TS2, TS3*. Superior, middle, and inferior temporo-sphenoidal convolutions; *O1, O2, O3*. Superior, middle, and inferior occipital convolutions, *R''*. Broca's convolutions[2]

II. CEREBRAL LOCALIZATION.

The brain is essentially but a continuation and expansion of the spinal cord. It consists of the same elements, viz., gray matter forming centres of function, and white matter composed of nerve tissue for conduction. To determine the precise location of these functional centres has been the most recent effort of physiological experiment. The effort has thus far proved only partially successful, but the results obtained give promise of a complete topographical survey of the entire brain which at no distant day will provide the surgeon a chart that will guide him accurately in all his operations upon that organ. At present the motor and sensory functional centres of the regions of the face, tongue, arm, and leg, have been established with sufficient certainty to render a knowledge of these centres obligatory upon the surgeon. As in the spinal cord, so in the brain, the nerves supplying the sensory surfaces of a region, and those supplying the muscles of that region, have origins from centres lying in close relations. The motor and sensory centres of the regions above mentioned are located, chiefly, in the central region of the cerebral cortex, viz., in the ascending frontal convolution, *F4, F4'* (Fig. 336), and the ascending parietal convolution, *P1, P2* (Fig. 336), on either side of the fissure of Rolando. The precise division of this region into functional centres is as follows:—

---

[1] Lucas-Championnière.

[2] J. E. Erichsen.

(*a*) **The face** is supplied with both motor and sensory nerves, having their origin in the lower third of the central region. The motor nerves from the anterior part of this area, $F4$, supply the muscles of the upper part of the face, and those from the lower and posterior part, R'' and $P1'$, the muscles of the lip and mouth. The sensory nerves of the face have nearly the same origin, though the distinction is made that the motor nerves have the larger origin from the frontal ascending, and the sensory from the parietal ascending convolutions.

(*b*) **The arm** has its motor and sensory supply from the middle portions of the central regions, viz., from the middle portion of the ascending frontal, and from the middle of the ascending parietal, at about the point marked R''. The sensory nerve-supply of the arm is more from the middle of the ascending parietal $P1$.

(*c*) **The leg** derives its motor and sensory nerve-supply from the upper portion of the ascending frontal, $F4'$, and ascending parietal, $P2$. These two convolutions coalesce above the extremity of the fissure of Rolando, and form the paracentral lobule at R. In this lobule the motor and sensory functions of the leg are combined as far as the longitudinal sinus.

(*d*) **The tongue** is supplied with nerves from the posterior extremity of the third or inferior frontal convolution, $F3$, R'', of the left side in right-handed persons, and at a similar point on the right side in left-handed persons.

In the application of these facts in diagnosis it must be remembered that, by the decussation of the nerve fibres, the lesion of the brain is, with certain exceptions, on the side opposite that which manifests the symptoms. The following summary of indications of local lesions, as expressed by symptoms, will prove useful:—[1]

(*a*) **In regard to motion,** spasm of one group of muscles, monospasm, indicates irritation of the corresponding motor area in the brain cortex. Paralysis of the same group of muscles indicates destruction of the same motor area. Spasm or paralysis of two of these groups indicates that the lesion involves more than one area, for example: Paralysis of one side of the face and of the corresponding arm indicates a destructive lesion of the lower and middle thirds of the central region; paralysis of the arm and corresponding lower limb points to a destructive lesion of the middle and upper thirds of the central region. Spasm would indicate similarly located irritative lesions. Paralysis of face, arm, and leg, hemiplegia, would indicate destructive lesion of the lower, middle, and upper thirds of the central region; and spasm of the same muscle, irritative lesion of all three portions of the central region; except that it must be remembered that a primary lesion of one area sometimes affects secondarily the neighboring area or areas and causes hemiplegia.

(*b*) **In regard to sensation,** hyperæsthesia, pain, or paræsthesia of the face, arm, or leg, indicates irritation of the corresponding sensory area in the brain cortex. Anæsthesia and analgesia indicate destruction of the corresponding sensory area in the brain cortex. Hyperæsthesia or anæsthesia of two cutaneous tracts indicates that the lesion involves more than one area. For example: Anæsthesia of one side of the face and of the corresponding arm indicates a destructive lesion of the lower and middle third of the central region, probably situated behind the fissure of Rolando, and also in the parietal convolutions. Anæsthesia of the arm and corresponding lower limb points to a destructive lesion of the middle and upper third of the central region, probably situated behind the fissure of Rolando, and also in the parietal convolutions. Hyperæsthesia would indicate similarly located irritative lesions. Anæsthesia of face, arm, and leg, hemianæsthesia, would indicate destructive lesion of the lower, middle, and upper thirds of the central region, probably situated behind the fissure of Rolando, and in the parietal convolutions; and hyperæsthesia of the same cutaneous tracts irritative lesion of all three portions of the central region, probably situated behind the fissure of Rolando, and in the parietal convolutions. If motor paralysis is associated with these sensory disturbances in a cortical lesion, the probability is, that we have a lesion involving both the ascending and the parietal convolutions. If the motor paralysis is slight, the lesion probably predominates in the parietal convolutions.

---

[1] J. B. Roberts.

(*c*) **Disturbance in speech power**, aphasia, indicates disease in the neighborhood of the fissure of Sylvius on the left side in right-handed persons; on the right side in left-handed persons. Aphasia may be due to loss of: 1. Memory of words, sensory aphasia, whose centre is situated in the first temporo-sphenoidal convolution. 2. Memory of voluntary acts necessary to speech, motor aphasia, whose centre is situated in the posterior part of the third frontal convolution and lower part of central region, ascending frontal convolution. 3. Connection between the regions just described, aphasia of incoördination, which is required to turn thought into speech. This function is located in fibres passing through island of Reil and lower part of central region, ascending frontal convolution.

In estimating the value of these symptoms in diagnosis it should be stated that recent researches[1] have shown that some motor symptoms may be due to traumatic irritation of the dura mater, non-correspondence of the symptoms, observed in a given case, with the typical symptoms described as accompanying a lesion in that locality, may be due to a dural lesion, in addition to the cortical lesion; and, on the other hand, certain observed symptoms may be caused by dural rather than cortical lesions. This is owing to the nerves distributed in the dura mater.

III. CRANIO-CEREBRAL TOPOGRAPHY.

To make a knowledge of the location of the centres of function of the brain available it is necessary to be able to determine upon the exterior of the cranium the precise points underneath which they may be found. The principal cerebral landmark is the sulcus of Rolando which, as has been seen, divides the two chief convolutions of the central region. The terminal points of this sulcus has been fixed as follows:[2] Draw a line directly backwards from the external angular process of the frontal bone 7 centimetres (Fig. 337), and from the posterior extremity of this line raise a vertical line 3 centimetres, and the upper end of this will correspond with the termination of the sulcus. Or, the upper end of the sulcus is 5 centimetres posterior to the junction of the sagittal and coronal sutures. This point, the bregma, may be located by a line projected upward from the external meatus at right angles with another that passes from the base of the upper incisor teeth to the base of the occiput, this latter line being horizontal by the position of the head.

A more complete system of measurements, and one which renders the main facts of cranio-cerebral topography readily available to the surgeon, is as follows:—[3]

---

[1] H. Duret; J. B. Roberts. [2] Lucas-Championnière. [3] R. W. Reid.

Fig. 337.

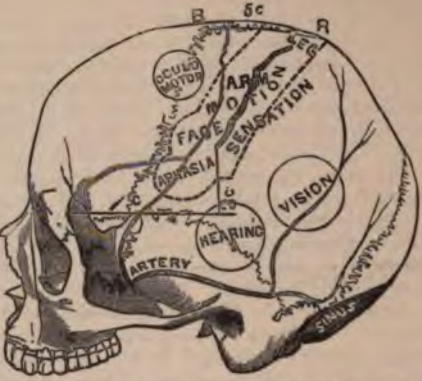


Diagram of the Exterior of the Skull. Upon this have been indicated the measurements for determining the position of the fissure of Rolando; and the location of the regions under which lie the centres of motion and sensation, as well as those of vision and hearing, and the oculomotor centre. The position of the grooves for the two branches of the middle meningeal artery and for the lateral sinus is also shown.

It must be understood that it is impossible to draw a line on the scalp exactly to follow a sulcus of the brain, for the simple reason that the sulci are never in any two brains precisely alike, or the shape of the head exactly the same in all cases. Also, that, as the surface area of the outside of the scalp is greater than the surface area of the corresponding part of the cerebrum, any lines drawn on the scalp to represent the sulci will be longer than the sulci themselves, and the spaces between those lines, indicating the convolutions, will be larger than the convolutions themselves.

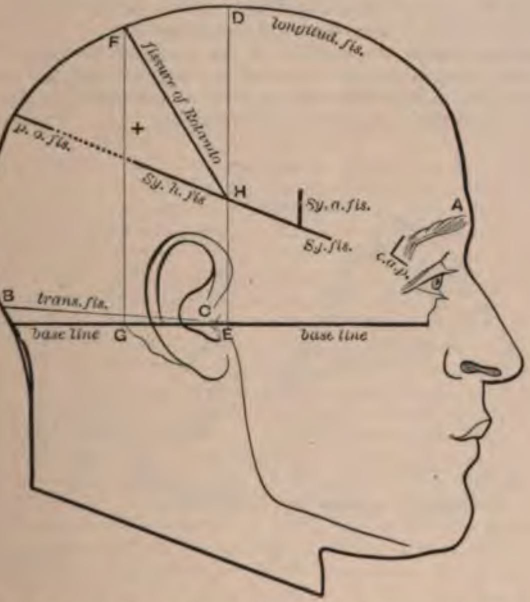
However, by taking large and easily felt landmarks on the head, and drawing from these certain lines, those lines will indicate accurately enough for all practical purposes the position of the principal sulci, and by removing in any of these lines a piece of the scalp and skull an inch square, or by applying the one inch trephine to the skull, with the centre pin on the line, we can expose the fissure on any part of its course. The landmarks which can easily be felt on the outside of the scalp, and with reference to which lines can be drawn to indicate the position of the sulci are the glabella, or depression between the two nasal eminences just above the root of the nose, external occipital protuberance, superior curved line of the occipital bone, parietal eminence, posterior border of the mastoid process, depression just in front of the external auditory meatus, external angular process of the frontal bone, frontal part of temporal ridge, and the supraorbital notch. If the last is not to be felt, its position will be at the junction of the inner with the middle thirds of the supraorbital margin. The base line (Fig. 338), from which all perpendicular lines are drawn, runs through the lowest part of the infraorbital margin and the middle of the external auditory meatus.

The longitudinal fissure of cerebrum is readily indicated by a line running along the middle line of the top of the head from the glabella to the external occipital protuberance.

The transverse fissure is indicated by drawing a line along the superior curved line of the occipital bone from the external occipital protuberance to the external auditory meatus—that is, along the line of junction of the head with the neck posteriorly.

The fissure of Sylvius is found by drawing a line from a point one inch and a quarter behind the external angular process of the frontal bone to a point three-quarters of an inch below the most prominent part of the parietal eminence; measuring from before backwards, the first three-quarters of an inch of the line will represent the main fissure, and the rest of the line will indicate the horizontal limb; the ascending limb will start from the posterior end of the line indicating the main fissure—that is, two inches behind and slightly above the external angular process—and run vertically upwards for about an inch (*Fig.* 338).

Fig. 338.



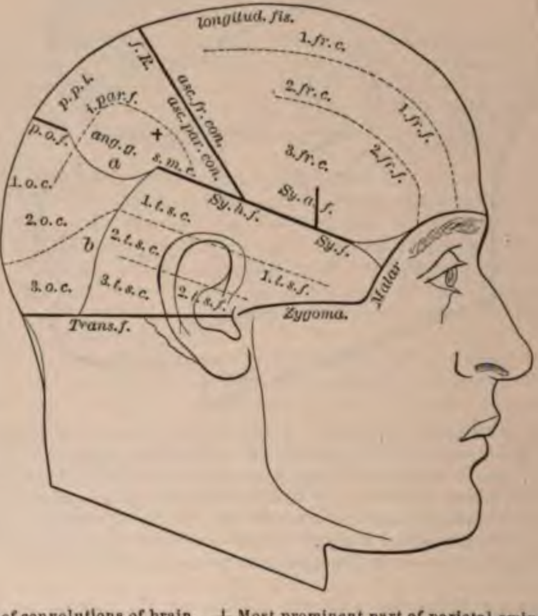
Topography of the fissures of the brain. *A*, Glabella. *B*, External occipital protuberance. *e. a. p.*, External angular process of frontal. *B C*, Transverse fissure. *A B*, Longitudinal fissure. *Sy. fis*., Sylvian fissure. *Sy. h fis*., Horizontal limb of fissure of Sylvius. *Sy. a. fis*., Ascending limb of fissure of Sylvius. *D E*, Perpendicular line from depression in front of external auditory meatus to middle line of top of head. *F G*, Perpendicular line from posterior end of base of mastoid process to middle line of top of head. *F H*, Fissure of Rolando. *p. o. fis*., Parieto-occipital fissure. + Most prominent part of parietal eminence.

The fissure of Rolando and the region of the ascending frontal and parietal convolutions are found thus: first indicate on the surface of the scalp the longitudinal fissure and the horizontal limb of the fissure of Sylvius, next, from the base line draw two perpendicular lines to the top of the cranium, one *D E* (Fig. 338), from the depression in front of the external and auditory meatus, and another *F G* (Fig. 338), from the posterior border of the mastoid process at its root. We shall thus have described on the surface of the head a four-sided figure, bounded above and below by the lines for the longitudinal fissure and horizontal limb of the fissure of Sylvius respectively, and in front and behind by the two perpendicular lines. If we now draw a diagonal line *F H* (Fig. 338), from the posterior superior angle to the anterior inferior angle of the space, this diagonal line will lie over the fissure of Rolando. In the majority of cases the fissure of Rolando does not actually run into the fissure of Sylvius, a convolution bridging across at that point; hence the lowest half inch or so of the line would cross this convolution. In those cases where the two fissures join the fissure of Rolando would be indicated by the whole length of the line.

The external parieto-occipital fissure is more variable in its position than any of the other principal fissures of the cerebrum, and consequently any indication of it on the surface of the scalp must be approximately accurate. If we continue the line for the horizontal limb of the fissure of Sylvius onwards to the line indicating the longitudinal fissure, we shall find that on trephining over the inner inch of this line we shall expose the external parieto-occipital fissure, or some part of it. In most cases we have seen the whole of the fissure in the opening so made, in others it showed itself in the posterior half of the opening, and in still fewer cases it was seen in the anterior half.

Having now indicated the position of the principal fissures, it will be comparatively easy to map out the areas of the frontal, parietal, temporo-sphenoidal, and occipital lobes, with their chief sulci and convolutions as far as they are in relation with the outer surface of the scalp.

Fig. 339.



Topography of convolutions of brain. + Most prominent part of parietal eminence. *a*, Convex line bounding parietal lobe below. *b*, Convex line bounding temporo-sphenoidal lobe behind. *1 fr. c.*, First frontal convolution. *1 fr. f.*, First frontal fissure. *f. R.*, Fissure of Rolando. *Sy. f.*, Sylvian fissure. *Sy. h. f.*, Horizontal limb of Sylvian fissure. *Sy. a. f.*, Ascending limb of Sylvian fissure. *p. o. f.*, Parieto-occipital fissure. *i, par. f.*, Intraparietal fissure. *ang. g.*, Angular gyrus. *s. m. c.*, Supra-marginal convolution. *1 t. s. c.*, First temporo sphenoidal convolution. *1 t. s. f.*, First temporo-sphenoidal fissure. *1 o. c.*, First occipital convolution. *p. p. l.*, Postero-parietal lobule.

The frontal lobe will be bounded above by the line for the longitudinal fissure, below by the line for the trunk and horizontal limb of the Sylvian fissure, behind by the line for the fissure of Rolando, and in front by a line just above and parallel with the supra-orbital margin. A line drawn from the supra-orbital notch backwards to within three-quarters of an inch of the line for the fissure of Rolando, and parallel with the line for the longitudinal fissure, will indicate the first frontal fissure. The frontal part of the temporal ridge will indicate the second frontal fissure. The first, second, or third frontal convolutions will thus be mapped out. The ascending frontal convolution will occupy a space about three-quarters of an inch broad parallel with, and in front of, the line for the fissure of Rolando (Fig. 339).

The parietal lobe will be marked out by the line for the longitudinal fissure superiorly, and in front and behind by the lines for the fissure of Rolando and the parieto-occipital fissure respectively. Below, the line for the horizontal limb of the fissure of Sylvius will separate it from the temporo-sphenoidal lobe. The interval between the posterior end of the Sylvian line and the outer end of the parieto-occipital line is occupied by the junction of the postero-parietal lobule (*p. p. l.*, Fig. 339) with the first annectant convolution and the angular gyrus (*ang. g.*, Fig. 339) with the second annectant convolution, the arrangement of these convolutions with regard to one another being very variable, the angular gyrus usually projecting somewhat more posteriorly than the postero-parietal lobule. We can therefore only indicate the separation of this part of the parietal lobe from the neighboring temporo-sphenoidal and occipital lobes by drawing a line (*a*, Fig. 339) slightly convex downwards from the posterior end of the Sylvian line to the outer end of the parieto-occipital line. An irregularly triangular space will thus be marked out to indicate the parietal lobe. If in this space we draw a line from a point half an inch outside the outer extremity of the parieto-occipital line to a point about an inch above and behind the anterior and inferior angle of the space, this line will lie over the *intra-parietal fissure* (*i. par. f.*, Fig. 339). The line must be curved, with its convexity directed forwards and inwards, and parallel in its anterior third or so with the line of the fissure of Rolando, and about three-fourths of an inch behind it. In the space above the intra-parietal sulcus we shall have, in front, parallel with the whole length of the fissure of Rolando, the ascending parietal convolution, and behind, the postero-parietal lobule. The space below the sulcus will indicate, in its anterior part, the supra-marginal convolution (*s. m. c.*, Fig. 339), filling up the most prominent part of the parietal eminence, and, in its posterior part, the angular gyrus (*ang. g.*, Fig. 339).

The temporo-sphenoidal lobe, like the last, is somewhat difficult to indicate posteriorly, because it becomes continuous there with the parietal and occipital lobes without any distinct line of demarcation. Its outline will lie in the lower part of the temporal region, extending a little beyond the temporal ridge behind. It will be bounded above by the line of the main trunk and horizontal limb of the fissure of Sylvius, below by the upper border of the zygoma and a line carried back from the posterior end of that to a point midway between the external occipital protuberance and the posterior border of the mastoid process at its root. The anterior border or apex of the lobe will extend as far forwards as the posterior superior border of the malar bone. Behind, the lobe will be bounded by a slightly convex line (*b*, Fig. 339), with the convexity directed backwards, extending from the posterior end of the Sylvian line to the posterior end of the line indicating the lower boundary of the lobe. A line running about one inch below and parallel with the line for the main trunk and horizontal ramus of the fissure of. Sylvius will indicate the first temporo-sphenoidal fissure (1 *t. s. f.*, Fig. 339), and another line about three-quarters of an inch below and parallel with the last will indicate the second temporo-sphenoidal fissure (2 *t. s. f.*, Fig. 339). Thus the first, second, and third temporo-sphenoidal convolutions will be mapped out (1 *t. s. c.*, 2 *t. s. c.*, 3 *t. s. c.*, Fig. 339).

The occipital lobe will occupy the remaining surface of the scalp. It will be bounded above by the parietal lobe, below by the superior curved line in its inner half—that is, the part of the line unoccupied by the lower limit of the temporo-sphenoidal lobe. Internally the line of the longitudinal fissure, and externally the convex line for the posterior border of the temporo-sphenoidal lobe, will bound it. The area of the lobe being marked out, the first, second, and third occipital convolutions can be readily filled in (1 *o. c.*, 2 *o. c.*, 3 *o. c.*, Fig. 339).

IV. INDICATIONS FOR TREPHINING.

The localization of functional centres has given new indications for operative interference in injuries of the brain. The following summary[1] may be accepted as expressing the latest views of the indications for trephining. The symptoms are first given; then the presumed seat of lesion as expressed by the symptoms; finally, the indications as to the use of the trephine as determined by symptoms and locality.

(*a*) **Hemispasm, or Incomplete hemiplegia, or Hemispasm with hemiplegia**; lesion on the opposite side of the body after even slight injury in the fronto-parietal region, and even when not directly over the motor area; indicates exploratory operation at the site of injury.

(*b*) **Monospasm, or Monoplegia,** whether total or incomplete; lesion on the opposite side of the body after even slight injury in the fronto-parietal region, and even when not directly over the motor area; indicates, indeed demands, exploratory operation at the site of the injury.

(*c*) **Hemihyperæsthesia, or Hemianæsthesia, or Hemianalgesia, or Hemihyperæsthesia with hemianæsthesia or hemianalgesia**; lesion on the opposite side of the body after even slight injury in the parieto-occipital region near or somewhat behind the motor area; may indicate exploratory operation at the site of injury.

(*d*) **Monohyperæsthesia, or Monoanæsthesia, or Monoanalgesia**; lesion on the opposite side of the body after even slight injury in the parieto-occipital region near or somewhat behind the motor area; may indicate, or may perhaps demand exploratory operation at the site of injury.

The symptoms, above mentioned, if on the same side as the injury, contra-indicate operation at the site of the injury, but may indicate exploratory operation on the side of the cranium opposite the injury.

(*e*) **Coma, with Hemispasm, or Hemiplegia,** in cases of supposed subcranial or arachnoid hemorrhage, may indicate exploratory operation on the side opposite the paralysis or spasm.

(*f*) **Coma, with Hemihyperæsthesia or Hemianæsthesia, or Hemianalgesia,** in cases of supposed subcranial or arachnoid hemorrhage, may indicate exploratory operation on the side opposite the hyperæsthesia, anæsthesia, or analgesia.

V. CONTRA-INDICATIONS TO TREPHINING.

It is quite true that cerebral localization is as valuable when informing us to abstain from operation as when indicative that speedy operation is demanded.[1]

(*a*) **Paralysis of one or more cranial nerves, Neuro-retinitis, Cheyne-Stokes** respiration, or other symptoms showing lesions probably at the inaccessible base of the brain, or in undeterminable parts of its interior, even if other symptoms indicate operation are, except in cases of supposed cerebral abscess, contra-indications to exploratory operation.

(*b*) **Complete hemiplegia,** which often is not of cortical origin, but is due to lesions of deep structures, is, except when—1, it is due to a supposed cerebral abscess; 2, it has been incomplete at outset; 3, it is irregular, and corresponds with extensive depression of bone on opposite side of cranium, a contra-indication to exploratory operation.

---

[1] J. B. Roberts.

(*c*) **Hemispasm, or Hemiplegia,** with marked hyperæsthesia or anæsthesia, indicates more extensive cortical lesion than hemispasm or hemiplegia alone, and may even be due to deep lesions, and is, except when, 1, the hyperæsthesia or anæsthesia is limited to a small cutaneous surface, monoæsthesia; 2, the hyperæsthesia or anæsthesia is apparently due to the same cortical lesion that causes the spasm or paralysis, a contra-indication to exploratory operation.

(*d*) **Hemispasm, or Hemiplegia** on same side as injury, may, if other symptoms indicate operation, be an indication for operation on the side of the cranium opposite to that of the injury, but is a contra-indication to exploratory operation on the injured side of the cranium.

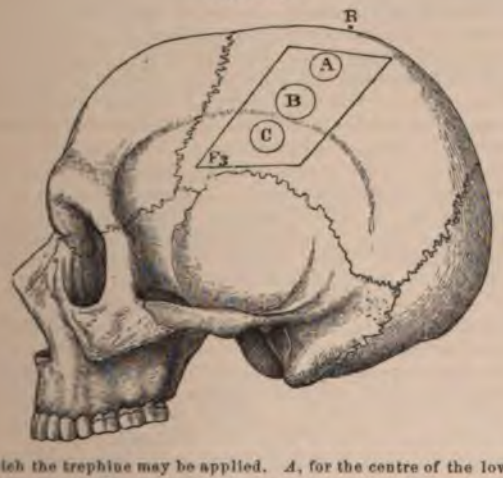
(*e*) **Hemihyperæsthesia, or Hemianæsthesia, or Hemianalgesia** with marked spasm or paralysis, indicates more extensive cortical lesion than hemihyperæsthesia or hemianæsthesia, hemianalgesia alone, and may even be due to deep lesions, and is, except when, 1, the spasm or paralysis is limited to a small group of muscles, monoplegia; 2, the spasm or paralysis is apparently due to the same cortical lesion that causes the hyperæsthesia or anæsthesia, a contra-indication to exploratory operation.

(*f*) **Hemihyperæsthesia, or Hemianæsthesia, or Hemianalgesia,** on same side as injury, may, if other symptoms indicate operation, be an indication for operation on the side of the cranium opposite to that of the injury, but is a contra-indication to exploratory operation on the injured side of the cranium.

VI. INDICATIONS AS TO POINTS WHERE THE TREPHINE SHOULD BE APPLIED.

The symptoms of cerebral lesions at once indicate, not only the necessity for or against trephining, but point out the precise locality where the instrument should be applied. These indications have been formulated as follows:—[2]

Fig. 340.



Situations in which the trephine may be applied. *A*, for the centre of the lower limb; *B*, for the upper limb; *C*, for the centre of the face; F_3, situation of Broca's convolution.[1]

---

[1] J. E. Erichsen.

[2] J. B. Roberts.

(*a*) **Hemispasm or hemiplegia**; lesion along entire length of fissure of Rolando, or possibly along a portion of its extent, and involving other areas secondarily, more probably in front rather than behind fissure; trephine over middle of fissure of Rolando, and to be extended downwards, upwards, and forwards in search for lesions, rather than backwards, unless disturbances of sensation have been present; then backward extension is indicated. If aphasia is present the opening should be extended downwards and forwards.

(*b*) **Crural monospasm or monoplegia**, convulsions or paralysis limited to one leg, or part of one leg; lesion in upper third of central region in ascending convolutions and astride of upper end of fissure of Rolando. Possibly in front rather than behind fissure (?). Some say in ascending parietal convolution rather than in frontal; trephine over upper end of fissure of Rolando, and to be extended forwards rather than backwards, unless disturbance of sensation is present.

(*c*) **Spasm or paralysis** of both legs; not due to spinal lesion: lesion in upper part of central region, and paracentral lobules on both sides; trephine over middle line between upper ends of both fissures of Rolando, to be extended towards the side of vault of cranium which is opposite to the side of the more pronounced symptoms. Take care to avoid if possible injury to superior longitudinal sinus.

(*d*) **Brachial monospasm, monoplegia**, convulsions or paralysis limited to one arm, or part of one arm; lesion in middle third of central region in ascending convolutions, especially in ascending frontal; trephine over middle third of fissure of Rolando, but rather more in front than directly over the fissure, though the fissure should be uncovered; to be extended forwards rather than backwards, unless disturbance of sensation is present. Facial spasm or paralysis is often associated with the crural symptoms; as by hemorrhage gravitating downwards, etc.

(*e*) **Associated crural and brachial monospasm, or monoplegia**; lesion in upper two-thirds or at junction of upper and middle thirds of central region, probably in ascending frontal rather than in ascending parietal convolution; trephine over junction of upper and middle thirds of fissure of Rolando.

(*f*) **Facial spasm or paralysis**; lesion in lower third of central region, especially in ascending frontal and posterior end of second frontal convolutions. The anterior part of this area seems to control chiefly the motions of the upper part of the face, and the posterior part of the motions of the lips or mouth; trephine in front of lower third of fissure of Rolando, though the posterior edge of opening should be close to the line of the fissure of Rolando. Aphasia is often associated with the facial symptoms.

(*g*) **Aphasia**; lesion below and in front of lower end of fissure of Rolando, varying somewhat with form of aphasia. 1. Sensory aphasia in first temporosphenoidal convolution. 2. Motor aphasia in posterior part of third frontal and lower part of ascending frontal convolutions. 3. Aphasia of incoördination in vicinity of island of Reil. Aphasia in right-handed persons is due to lesion on left side of brain; in left-handed persons to lesion on right side of brain; trephine about a half inch (1.25 centimetres) below, and a half inch (1.25 centimetres) in front of the lower end of the fissure of Rolando. Single large opening will cover the convolutions for the three forms of aphasia, but the area for the third form is deeply situated in the fissure of Sylvius.

(*h*) **Associated brachial and facial spasm or paralysis**; the convolutions involved are those of arm and face as given above; trephine in front of junction of middle and lower thirds of fissure of Rolando.

(*i*) **Associated brachial and facial spasm, or paralysis with aphasia**; the convolutions involved are those of arm, face, and speech as given above; trephine in front of lower third of fissure of Rolando, and to be extended upwards or downwards and forwards according as brachial or aphasic symptoms are more pronounced.

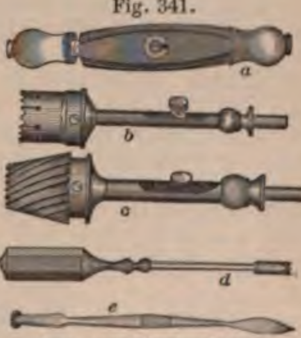
(*j*) **Associated facial spasm, or paralysis and aphasia**; the convolutions involved are those of face and speech as given above; trephine about a half inch (1.25 centimetres) directly in front of the lower end of the fissure of Rolando, and to be extended upwards and backwards, or downwards and forwards, according as facial or aphasic symptoms are more pronounced.

An example of the application of the principles of cerebral localization in practice is as follows:[1] A man had a blow on left side of head, and symptoms followed thus: Headache; in one year slight spasms of left side of face and tongue, which became paroxysmal; convulsions beginning with left side of face and tongue, extending to neck, arm, and leg, and then general; spasms of hand and arm, alternating with face; weakness of left hand and paresis of arm; twitchings of left eyelid, and left leg, and weakness of latter. Diagnosis: Tumor of limited size which destroyed the centres of the hand, and was irritating the centres of the leg, face, and eyelids. Location in the vicinity of the upper third of fissure of Rolando. The trephine was applied, membranes opened, and an incision an inch long and a quarter of an inch deep made in the cortex revealed a tumor the size of a walnut which was enucleated. Symptoms improved, but death occurred from a hernia cerebri at the end of a month.

VII. THE OPERATION OF TREPHINING.

This operation is required for the removal of a circular piece of bone, as in opening into cavities in bone. The instruments necessary are the trephine and elevator (Fig. 341). The trephine, *b*, *c*, *d*, is a cylindrical saw, with a cross handle like a gimlet, *a*, and a centre-pin, the perforator, around which it revolves until the saw has cut a groove sufficient to hold it; the centre-pin is then retired. The handle is fastened to the shaft by a screw, with a button affixed to the end of the shaft; or the screw may be on one end; when the handle is placed on the shaft this screw is tightened, and its extremity reaches the shaft and fastens it firmly in its place; the advantage of this arrangement is that the upper surface of the handle is smooth, and the palm of the hand is not bruised as it is by the handle of the old instrument. The conical trephine, *c*, has the peculiar advantage of dividing the osseous walls without any danger of wounding the structures within. It is a truncated cone, with spiral peripheral teeth.

Fig. 341.



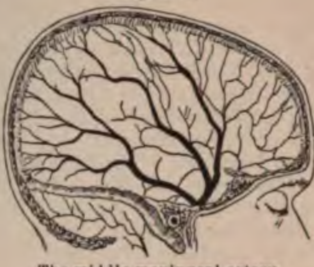
Instruments for trephining.

The operation on the skull should be performed as follows: Shave the scalp at the point where the operation is to be performed; place the head upon a firm pillow; give an anæsthetic when the patient is fully conscious; select the point of application of the crown of the trephine so as to avoid the main branches of the middle meningeal artery (Fig. 342), and the longitudinal and other sinuses; make an incision down to the bone, having the form T, V, +, or other shape, as may be necessary to expose the bone; carefully raise the pericranium over a space just sufficient to admit the trephine. If at any

---

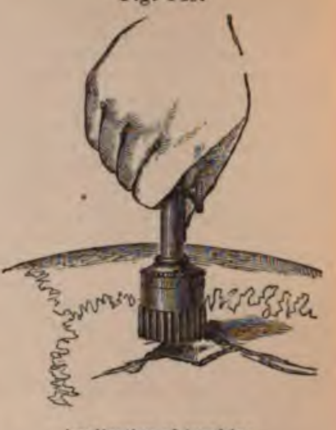
[1] H. Bennett; R. J. Godlee.

Fig. 342.



The middle meningeal artery.

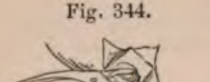
Fig. 343.



Application of trephine.

point the elevator can be introduced sufficiently to raise the fragment without using the trephine, elevate the depressed bone very cautiously, until its margin is on a level with the sound bone; if this is impracticable, place the pin upon the margin of the sound bone, and taking the handle in the right hand move it alternately to the right and left, until the teeth have cut a groove sufficiently deep to receive them; the pin is then loosened and slid up in the shaft and fixed, to avoid wounding the membranes. Great care should be taken to maintain the instrument in a position perpendicular to the part operated upon (Fig. 343), in order to avoid its penetrating more deeply on one side than the other and thus suddenly wounding the cerebral membranes. Examine the depth of the groove frequently to ascertain how nearly the instrument has completed the section of the bone, occasionally cleaning the teeth with a small brush or wet sponge; raise the disk of bone with the elevator. In fractures with depression there are frequently projecting points of bone which it is desirable to remove; this may be done with the rongeur (Fig. 344). If there is a blood clot, remove it with care, lest bleeding recur; if the meningeal artery is exposed and bleeds, compress it with a piece of sponge, cloth, or wood inserted under the margin of the bone; if the blood or pus producing compression are below the dura mater, open it sufficiently to remove these matters. The conical trephine is to be preferred in all cases where the bone is thin. The bichloride irrigation must be continued until the operation is completed; place a horse-hair or catgut drain in the angle of the wound, and close it with antiseptic suture of horse-hair or catgut; dust the surface with iodoform, salicylic acid, or naphthaline, and apply iodoform-gauze pads, and the capeline bandage to retain dressings. If the longitudinal sinus is injured, the bleeding may be arrested by picking up the margins of the vessel, and applying a ligature.

Fig. 344.



Removing projecting bone with rongeur.

CHAPTER XXIX.

INJURIES AND DISEASES OF THE SPINE.

I. INJURIES OF THE SPINE.

Accidents to the vertebral column derive their chief importance from the resulting injury to the spinal cord; certain portions are more frequently the seat of injury than others, namely, the dorsi-lumbar, the cervico-dorsal, and the atlo-axial.[1]

Concussion of the spine often develops symptoms of the most serious, progressive, and persistent character, not only after apparently slight injuries, but frequently when there is no sign whatever of external injuries.[2] It occurs usually as the result of a fall on the nates or back; the shock is generally not severe, even when the paraplegic condition is well marked; the effects may be immediate, or may not supervene for some time.[3] In direct, severe injury the primary symptoms vary with the place of injury, the force, and the amount of organic lesion of the cord produced; a blow on the upper cervical region may cause instant death, and on the dorsal region complete paraplegia; or there may be paralysis of motion, loss of power over the sphincters, alkaline urine, lowering of temperature of paralyzed parts. The secondary symptoms are usually those of development of inflammation in the meninges; namely, pain in some part or parts of the spine, increased by pressure and motion, and extending around the body, or down the limbs.[2] In the severest forms there are lesions which give rise to hemorrhage within the canal, and consequent paralysis; usually the blood proceeds from lacerations of the venous plexuses, and collects on the outside of the cord and its membranes, and in largest quantities behind and at the sides; in lesion of the cord itself the hemorrhage is slight, owing to the small size of its vessels.

In railway injuries, general shock is often, but not always, in excess of that which accompanies simple concussion; the collapse may be great, with insensibility, but without evidence of injury to the head; other symptoms are numbness and tingling, rigor, continued sickness, excito-motor spasm in the limbs, violent throbbing sensations, a sense of heat and cold in the head or other parts, want of sleep or continued drowsiness, confusion of intellect, enfeebled muscular power, deafness, defective sight with ocular spectra, hyperæsthesia in some parts, especially in the spine, great emotional excitability; with rare exceptions, there is extreme sensitiveness of the spine, more frequently located at some particular part.[3] In some cases entire recovery follows after a longer or shorter interval; in others the health is permanently enfeebled, and a life of protracted discomfort is entailed, or the sufferer sinks, emaciated and exhausted, into a premature grave, or becomes the victim of an acute disease.[3]

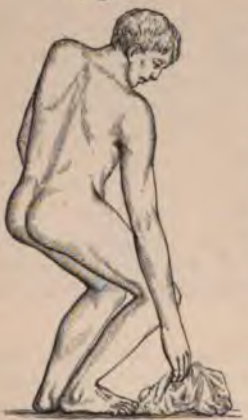
---

[1] A. Shaw. [2] J. E. Erichsen. [3] F. Le G. Clark.

The only treatment must be complete and absolute rest on a couch, in a prone position, rather than the supine, to avoid pressure on the back and relieve passive venous congestion, with dry cupping on either side of the vertebral column, and ice-bags, if comfortable; the secondary symptoms must be treated by continued rest and such counter-irritants as mustard poultices, stimulating embrocations, and, finally, setons and issues; when subacute meningitis begins, bichloride of mercury, in tincture of cinchona, is most beneficial; at advanced periods the iodide and bromide of potassium, in full doses, are useful; when inflammation has subsided and paralysis remains, strychnine, galvanism, and warm salt-water douches are required.[1]

Twists, sprains, or wrenches of the spine, without fracture or dislocation of the vertebræ, may occur in a variety of ways.[1] They usually result from violent bending and twisting of the column, and the force is chiefly expended on the joints and their ligaments; in the cervical and lumbar regions the impulse is broken and dispersed, owing to their mobility and elasticity; while in the dorsal region they have the character of a jar or jolt, owing to its rigidity.[2] They are most liable to occur in the more mobile parts of the column, as the neck and loins, and less frequently in the dorsal region; the head is frequently forcibly thrown forwards and backwards, moving as it were by its own weight, the patient having momentarily lost control over the muscles of the neck; the lumbar spine is often strained, with or without similar injury to the cervical portion of the column; the pain closely resembles that met with in any joint after a severe wrench of its ligamentous structures, but is peculiarly distressing in the spine, owing to the extent to which fibrous tissue and ligament enter into the composition of the column; there is aching pain in the articulations, greatly increased on pressure and motion of any kind to and fro, especially by rotation; the spine is rigidly inflexible, the patient being unable to stoop.[1] In attempting to pick up an article from the floor he sits down rather than stoops forwards (Fig. 345). If the sprain has lacerated the membranes of the cord, extravasation of blood follows, with gradually increasing paralysis.[2] The recovery depends upon (1) the extent of stretching of muscles and ligament; (2) the extension of the inflammation excited in and about the articulations to the interior of the spinal canal; (3) the immediate injury to the cord and its coverings. The treatment must depend upon the conditions observed in each case, but in general the remedial measures are the same as in concussion; namely, long-continued rest and efforts to prevent or subdue inflammation.

Fig. 345.



Inability to stoop in strain of the back.

In the most favorable cases recovery may be complete in a few weeks or months. But it often happens that the apparently slight injuries finally become serious, and hence the occurrence of a lengthened interval between the infliction of the injury and the development of spinal symptoms is unfavorable, as it indicates progressive structural change.[1] If the vertebral column is so weakened as to require artificial support for several months to enable it to maintain the weight of the head, it will probably never regain its normal strength and power of support.[1] When extravasation of blood takes place from the rupture of vessels without other injury of the cord, absorption may in time be so complete as to relieve the paralysis. The hopeless cases are those in which chronic inflammation has gone on to the development of atrophy, softening, or other structural changes, of the substance of the cord.[1]

---

[1] J. E. Erichsen. [2] A. Shaw.

It is a safe rule in interpreting these symptoms, particularly in a railway case, or where the question of damages is involved, to separate the symptoms into, 1, the subjective, or those of which the patient complains, but which cannot be appreciated by the examiner, and, 2, the objective, or those which the examiner can perceive. It is proper to doubt the truth of the former, and test their accuracy by every possible means; a positive opinion can only be based on the latter. There always hangs a suspicion over the former because self-interest points to making the worst of them.[2]

Fractures of the vertebræ[3] derive their chief importance from their relations to injuries of the cord. Wherever the column is broken from the occiput to the second lumbar vertebra where the medulla spinalis terminates, the cord partakes of the injury, and all of the body below the fracture at once loses, more or less completely, both motor power and sensation, and hence the higher in the spine the fracture occurs the graver will be the consequences; owing to the small size of the medulla, both the motor and sensory tracts of the cord are generally deprived of their functions simultaneously; the extent of the injury to the cord may vary from the slightest lesion to a complete rupture, the degree depending upon the violence applied. When the cord is severely injured the symptoms are those of general shock to the nervous system; at first there is profound collapse; on recovery, pain is severe at the seat of injury, especially on motion; there are irregular projections and depressions in the processes of the vertebræ; paralysis of the whole body below the level of the fracture; the urinary bladder becomes distended from paralysis of the muscles; the feces are retained, or pass involuntarily.

The symptoms will be modified, according to the locality of the fracture, as follows: Below the second lumbar vertebra there may be an absence of paralysis and complete recovery; between the second lumbar and tenth dorsal the paralysis is more often partial, motor power being lost while sensation remains, and recovery is very frequent; between the tenth and fourth dorsal the cord is more likely to be crushed through its whole thickness, owing to its small size, followed by imperfect respiration, complete paraplegia, finally, bed-sores and exhaustion; between the second dorsal and fifth cervical, the cord will more likely be crushed and broken down in its substance than compressed, the body below is paralyzed, the respiration becomes more and more embarrassed, through paralysis of the intercostal and abdominal muscles, and death ensues in five to eight days; if at the fifth or fourth cervical the upper extremities are included in the paralysis, death may be expected within a few hours; if the fracture occur above the level of the fourth cervical, with crushing of the cord, instant death will ensue, as the function of the phrenic nerve is destroyed.

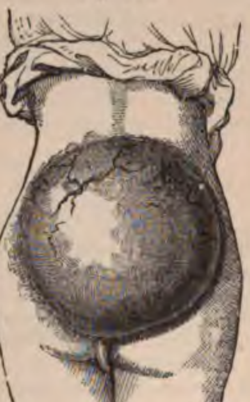
The treatment should at first aim to protect the cord from further injury: guard against motion of the spine in transportation by placing the patient on a firm support, as a door or shutter; if the neck is fractured, steady the head by sand-bags; cut off the clothes, and if there is much projection, gently stretch the body, as but slight change in the position of the patient is all that is needed, and when laid flat on his back the parts tend of themselves to come into correct apposition; the bed should be selected with a view to protect the back and hips from undue pressure, and prevent all motion of the spine; the water-bed is the best, and next, a narrow, low one, with boards instead of sacking, and two or more elastic, yet firm, horse-hair mattresses, covered by rubber cloth; provision may be made to allow the escape of urine and feces into a receptacle under the bed by the use of rubber drawers, having a tube passing through the bed to the vessel below; draw off the water with a full-sized catheter, and repeat the operation twice daily, washing out the bladder with tepid water slightly acidulated with nitric acid; the greatest care should be taken to prevent bed-sores by keeping the bed dry and relieving pressure by pillows, pads, and rugs for the hips; if they form, they must be cleansed with carbolic solutions, and protected from all irritants; such remedies as leeching and trephining the spine are to be discarded. The plaster-of-Paris jacket, as employed in spinal caries, may be applied with advantage in many cases.

---

[1] J. E. Erichsen. [2] T. Bryant. [3] A. Shaw.

II. DEFECTS OF THE SPINE.

Fig. 346.



Large spina bifida.[1]

Spina bifida (Fig. 346) is a defect in the bones of the spinal column, which admits the protrusion of the membrane in the form of a hernia; it is of the same nature as a meningocele, and contains subarachnoid fluid, and often nerve trunks, and even the spinal cord itself; hydrocephalus often exists at the same time; the defect may exist at any point in the column, cervical, dorsal, lumbar, or sacral, but the lumbo-sacral form is most frequent; the tumor may have a broad or very narrow base, and directly open into the spinal canal, or be quite disconnected; its coverings may be quite thick, or so thin as to be transparent, or ulcerated so as to allow the escape of its contents; it is usually quite tense when the child is awake and erect. In general this affection proves fatal, sometimes owing to the defective organization of the child, in other cases from convulsions, or an inflammation following an opening of the sac. No case of spina bifida ought ever to be subjected to any active operative interference, except in the most urgent circumstances, and the mildest measure which affords any rational prospect of cure should be the one selected.[2] It may be treated by punctures with needles and compression, the punctures being at the side to avoid nervous tissue. Or it may be repeatedly punctured, the fluid withdrawn, followed by strong compression. Injections of iodine may be used, as follows: Draw off several ounces, then inject five grains of iodine, and fifteen grains of iodide of potassium dissolved in an ounce of water; after a few seconds, allow this fluid to flow out, wash the sac with water, and inject two ounces of the original cerebro-spinal fluid.[1] Pressure around the neck of the sac may be made to bring the internal surfaces in contact and secure adhesions, and thus shut off the cavity of the tumor from the spinal canal, and admit of its excision. Excision has been successful when there was no nervous tissue in the sac, and the pedicle was small, after applying a clamp several days and thus exciting new action in the sac.[2] If the base is broad dissect the soft parts from the sac, opening it by free incision on one side, removing a portion, but reserving a flap to be attached to the root of the pedicle on the other side of the opening into the spinal canal.[3] Evacuation of the contents of the sac, pushing its collapsed parietes back into the canal, and uniting the soft parts over all sufficiently tight to prevent protrusion,[4] may be attempted; these operations must be antiseptic.

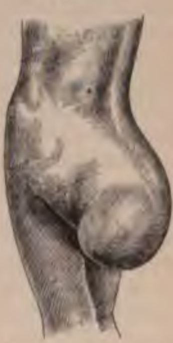
---

[1] J. E. Erichsen.

[2] T. Holmes.

Growths form about the sacrum and coccyx, which are usually cystic in their character. They have been mistaken for spina bifida. When located about the coccyx they may grow to large size, and become extremely inconvenient (Fig. 347). They should be cautiously removed with antiseptic precautions.

Fig. 347.



Congenital coccygeal tumor.[5]

CHAPTER XXX.

INJURIES AND DISEASES OF THE NERVES.

I. INJURIES OF THE NERVES.

NERVES, like other tissues, are subject to lesions from physical agencies, which may act without breaking the skin, simple lesions, or may involve the integument; the latter nerve wound is less grave than the former.[6]

Contusion of nerves[6] is a common incident of civil practice; as a rule, a blow with any blunt instrument over the length of a nerve is unlikely to be serious; but in the same injury to a nerve at its exit from a bony foramen, or where it rests in a furrow of bone, or lies superficially on the prominence of a joint, the consequences may be much more severe; a frequent cause of contusion of nerves is the dislocation and reduction of bones, especially at the shoulder-joint, where the nerves are liable to be bruised by being pressed between the head of the humerus, the first rib, and clavicle. When violent contusions do not cause immediate symptoms of loss of function, numbness and tingling may succeed to the first shock of pain, and only after a time be replaced by grave troubles, due to changes in the bruised nerve. When contusion is followed in a few days by slight numbness and prickling associated with growing tenderness over the nerve track, prompt treatment is necessary, as there is a commencing neuritis, or of a sclerotic state which may or may not be of inflammatory origin; the nerve may sometimes be felt in thin persons as a firm cord; in some cases the evil is most insidious, and may result in large functional losses without any notable pain or tenderness. The proper treatment for a contused nerve is absolute rest, with the use of leeches and cold water when symptoms of neuritis are present; apply three or four leeches twice weekly along the nerve, and cold continuously, unless disagreeable to the patient; inject morphia if the pain is severe; later, opium plaster along the nerve is useful, and if pain is intermittent give quinine or arsenic.

---

[1] D. Brainard.
[2] Wilson.
[3] T. Holmes.
[4] B. Chase.
[5] T. Bryant.
[6] S. W. Mitchell.

Compression of nerves[1] by external and internal causes is frequent, as by cicatrices, callus, tumors, parturition, fecal accumulations, malposition during sleep, use of a crutch; the effect of pressure upon a nerve is to disturb the contents of the nerve tubes in such manner that impressions are no longer conveyed until the pressure is removed and the continuity of the contents of the nerve tube is restored. The symptoms are: (1) delusive impressions, as formication, prickling, sense of warmth; (2) a seeming return to the normal condition and feelings; (3) hyperæsthesia, all the functions exalted, muscular power unchanged; (4) anæsthesia and muscular palsy, preceded by a sense of roughness of the skin, burning, muscular weariness, vague cramps. When the pressure is removed recovery takes place in a reverse order: (1) there is first pain, tickling, sensibility; (2) sudden sense of cold and feeling of enormous weight; (3) awkward motions, with formication; (4) regular motions and sense of heat. The treatment consists in removing the cause, and meeting the inflammatory symptoms with the remedies directed in cases of contusion.

Wounds of nerves[1] may be incised or punctured. The incised wound is caused by severe cuts, as with a knife, or glass. It is of great importance to make out first the extent of injury, and this may be done by examining as to the local paralysis. If the nerve is partially divided, cleanse the wound of all foreign matter with carbolic solutions; close it with sutures or adhesive strip; place the limb in a position to relax the tissues and approximate the cut ends; enjoin perfect rest; apply cold. Where it is plain that the nerve trunk has been altogether divided, the silver wire suture may be used to approximate the extremities; it should be inserted near the cut surfaces, or through the loose tissue related to its sheath; the wound should then be accurately closed; the restoration of function takes place only after long periods. Punctured wounds of small branches are more serious than of large trunks; they follow the use of the lancet as in venesection and vaccination, or other penetrating instruments. The symptoms are acute pain in the track of the nerve immediately or very soon, gradually increasing in severity until spasms or convulsions occur; slight injuries of the digital nerves seem especially prone to occasion distressing symptoms, and wide-spread reflex sympathies. The treatment is complete division if practicable; rest and cold to prevent inflammation; hypodermic injections of morphia to relieve pain.

---

[1] S. W. Mitchell.

II. DISEASES OF THE NERVES.

Inflammation,[1] acute, attacks, by preference, the nerves of robust persons and of adults; its seat is the neurilemma and the connective tissue between the bundles of fibres; the changes are due to deranged nutrition, and the nerve varies from a pale rose to a deep red color, and there is a variable increase in the diameter, its component bundles being separated from each other. The symptoms are a tearing, darting, lancinating pain along the course of the nerve trunk with a sensation of tingling, formication, or numbness; it never becomes suddenly severe, nor ceases suddenly, like neuralgia, but is continuous, though variable in severity; is always aggravated by pressure and by the contraction of muscles. The chronic form may result from the acute, or be a continuation of a mild attack, and is a frequent cause of certain kinds of neuralgia, neuroma, and painful subcutaneous tubercle. The treatment of the acute form is the local abstraction of blood, evaporating lotions or anodyne fomentations, and opiates to relieve pain.

Ulceration of nerves[1] occurs in the neighborhood of ulcers, and causes protracted suffering; the surrounding parts are often enlarged, the skin increases in thickness, the muscles and tendons ulcerate. The treatment is, ointment of well-powdered opium, or opium in water; if remedies fail, excise the nerves as far as possible from the ulcer; it is also advisable to divide the nerve as near the upper part of the wound as possible.

Painful subcutaneous tubercles[1] are spherical, or oval, or fusiform tumors, generally white, always firm, sometimes hard, having a fibrous or fibro-cartilaginous structure; the size varies from that of a millet-seed to that of a pea; they are situated in the subcutaneous areolar tissue, embedded between the fibres of nerves which are separated and stretched over them; they cause the most acute pains, which dart like electric shocks along the course of the nerve. Pain recurs very irregularly, and lasts from ten minutes to two hours or more; it begins gradually, increases in intensity, and gradually decreases, leaving the tubercle and parts around more or less tender; in all cases of obstinate neuralgia of the extremities, search should be made for these tubercles. The tumor must be removed; make a free incision down to the growth, and carefully dissect out the tumor and all the condensed tissues immediately around it. Close the wound by continuous suture, using a catgut drain at the deepest part.

---

[1] J. L. Clarke.

Neuromata[1] are tumors of nerve tissue, and are the cellular form which occurs in nerve centres, the fibrillar which is constituted of nerve fibres of new formation and occur in stumps; the plexiform which has not been determined are larger than subcutaneous tubercles, but may be of every size, from a small grain of wheat to a large melon; they are round, oblong, oval, or fusiform, and when superficial, movable only laterally; they are situated between the neurilemma and nerves, or in the connective tissue between the bundles of nerves; they consist for the most part of tough and wavy fibrous tissue with a variable number of nuclei and small cells. When they are numerous there is little or no pain, but a solitary neuroma is a source of the most violent agony, which shoots along the nerve like electric shocks. They frequently occur in stumps after amputation, rendering the limb both painful and intolerant of pressure. The only successful treatment is removal, either by excision of the tumor and a portion of the nerve, or by amputation of the limb.

Neuralgia[2] from nerve injury may depend upon pressure or the presence of foreign bodies, but more often it is a question as to whether the nerve is in a state of inflammation or sclerosis. If the former conditions exist, relief may be easy, as by removing the local cause. If the nerve is inflamed, repeated leeching and the steady application of dry cold for a week or two are the best remedies; if cold cannot be borne, hot poultices should be applied. The pains of traumatic neuralgia can only be satisfactorily relieved by narcotic hypodermic injections; the salts of morphia are to be preferred to all others; the fourth of a grain may be given and increased if necessary; if it is desired to maintain the anæsthetic power of morphia without the hypnotic effect, add atropia, thus: to half a grain of sulph. of morphia add one-thirtieth of a grain of sulph. of atropia. The alveolar processes sometimes undergo thickening and condensation after the removal of the permanent teeth, which causes such compression of the dental nerves that severe and persistent neuralgia results. The relief from this affection is most readily and effectually secured by removing the diseased process.[3] Make an incision along the ridge of the process; separate the periosteum from the bone by means of the elevator; with rectangular gnawing forceps remove the process to its entire depth; allow the parts to heal by the falling together of the surfaces of the wound. Dissection of nerve from the condensed cicatricial tissue following a gunshot wound has been performed[4] with success, as follows: The median nerve was inclosed in a dense cicatrix at the middle of the arm, involving the biceps muscle, resulting from a gunshot wound; the nerve was gradually laid bare and dissected out, so that it lay perfectly loose in the wound for an inch and a half or two inches of its length; the wound was lightly dressed, and allowed to heal; neuralgia returned slightly, with cicatrization, but eventually disappeared altogether. In extreme cases, amputation of parts is occasionally practised. Now that it is possible to prevent the reunion of nerves, amputation offers no advantages over resection of the nerve at some higher point; it can, therefore, never be justified, except where more than one nerve is involved, or where the limb has been rendered altogether useless by grave injury.[1]

---

[1] J. L. Clarke.

[2] S. W. Mitchell.

[3] J. M. Warren; S. D. Gross.

[4] J. M. Warren.

III. THE NERVOUS CONSTITUTION.

Neuromimesis,[2] nervous mimicry, should be duly considered in the diagnosis of surgical affections, for there is scarcely a local organic disease of invisible structures which may not be mimicked by nervous disorder. Examples are frequent in the more or less acute inflammations of the joints, especially of the knee and hip; it imitates diseases of the spine, paraplegia, tetanus, aphonia, deformities, aneurism, and tumors. It may be regarded as a localized manifestation of a certain constitution, but as to what is the peculiarity of the nervous constitution there is no positive knowledge; it may be stated that the nervous centres are too alert, too highly charged with nerve force, too swift in mutual influence, too delicately adjusted or defectively balanced, but these expressions may be misguiding, and it is better to study the nervous constitution in clinical facts. In the great majority of cases there is either history or present evidence of a characteristic nervous constitution; some have been or are truly hysterical, but very many have never been hysterical. The means for diagnosis are to be sought (1) in the general condition of the nervous system on which, as on a predisposing constitution, the nervous mimicry is founded; (2) in the events by which, as by exciting causes, the mimicry may be evoked or localized; (3) in the local symptoms of each case. The treatment is too varied to notice in detail, but must be directed against (1) the local symptoms; (2) the constitutional condition which may coexist or be combined with the nervous; (3) the nervous constitution itself.

CHAPTER XXXI.

GENERAL OPERATIONS ON THE NERVES.

The general operations on the nerves are suture, neurotomy, neurectomy, and stretching.

The suture of nerves favors cicatrization and regeneration of the peripheral ends; it has proved a harmless operation and is indicated in all cases of sections of nerves where the ends cannot be easily maintained in contact by position. The elastic bandage may be used. The search for the two ends of the cut nerve is very successful, as these structures have little contractility; if the wound is deep, enlarge it by an incision parallel with the nerve, in order to spare manipulation of the wound, which prevents immediate union and facilitates the passing of the threads. If the nerve prove to be clean cut and recent, proceed to pass the thread, but if crushed or cicatrized, resect a portion and then suture. The needle should be

[1] S. W. Mitchell.

[2] Sir J. Paget.

fine, and the thread prepared catgut. If the nerve ends can be brought and kept in perfect apposition by a suture involving only the sheath, do not penetrate the nerve tissue, but otherwise pass the needle through one end of the nerve to the under side and back through the other, and tie the thread; cut off both ends closely, and close the wound accurately with continuous suture, and apply gentle compression.

If the wound is deep, a drainage tube may be required. The nerve ends must be exactly adjusted. Union takes place in about two weeks. Suppuration must be prevented by antiseptics. If it is impossible to find the corresponding end of the nerve, and another nerve is found, two different nerves may be united.

Neurotomy, the section of a nerve, is justifiable only as a last resort, all other measures having failed.[1] It should always be made at a point which will involve as few terminal branches as possible, and yet the division must be sufficiently high to include all of the affected trunk, for if diseased tissue is left above the line of division, the subacute neuritis and sclerosis may continue to ascend the nerve and render the operation useless; it is important that the area of the painful region should be accurately determined, and the trunk carefully examined for enlargements and hardness by rolling the nerve under the finger; as a rule the section should be a short distance above the point at which the nerve ceases to feel enlarged and hard; if it is practicable to find a spot, even a little farther up the limb, where the nerve is neither swollen nor tender, select that point; when the nerve lies too deep for examination, especially if the neuralgia is of long standing and of traumatic origin, operate as near the body as possible; if the neuralgic cause is purely local, a healthy point is found.[2] But neurotomy, or simple division of a nerve, is at present scarcely ever practised, owing to the certainty of prompt reunion.

Neurectomy, the resection of a nerve, is to be preferred to neurotomy, and not less than two inches of its length ought to be removed, the object being to make reunion impossible, or very remote in point of time; in addition it is well to turn the peripheral extremity back, and if necessary secure it with a loop of wire, or even interpose muscle or fascia to prevent the possibility of union.[1]

Stretching of spinal nerves as a final resort for the relief of spasms[2] is now recognized as a justifiable operation, it has been employed also in locomotor ataxia. It originated in the exposure, isolation, and rubbing of the sciatic nerve[3] from a point below the gluteal fold, through the sciatic foramen, to the sacral foramen, for the purpose of relieving epilepsy supposed to be due to some irritating cause affecting the nerve. No such cause was found, but the stretching which the nerve received relieved the spasms. It is believed that the manipulation produces a favorable change in the position of the nerve fibres in the trunk, whereby their nutrition is improved. The procedure is essentially the same as that of dissecting a similarly affected nerve out of cicatricial tissue[1] long since successfully practised. The operation consists in exposing the nerve and stretching it with fingers, forceps, or blunt hooks, as if attempting to draw it from its connection to the spinal cord.

---

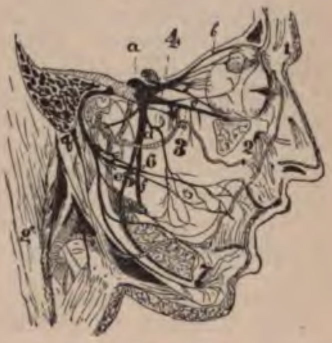
[1] S. W. Mitchell; W. A. Hammond; E. Brown-Séquard.

[2] Von Nussbaum.

[3] T. Billroth.

NERVES OF THE FACE, HEAD, AND NECK.

Fig. 348.



Nerves of the face.

The supra-orbital nerve (Fig. 348) is a terminal branch of the frontal, *b*, a portion of the first division of the fifth cranial nerve, *a*; it runs along the roof of the orbit, passes out through the supra-orbital foramen, and ascends upon the forehead. It should be divided as it emerges from the foramen, and before branches are given off. Section is made as follows, 1 (Fig. 348): Recognize the supra-orbital notch, or foramen; pass the tenotome subcutaneously from a point two or three lines on the inner side of the notch outward beyond the notch; turn the blade backwards and cut down to the bone. Resection is made as follows: Make an incision an inch in length down to the bone, just above the notch; seize the cut ends of the nerve in the wound and remove it to the desired extent. Or the brow may be raised and the lid depressed, and the incision be made along the edge of the border of the orbit; the nerve is seized in the wound and resected; the wound will fall under the brow when the skin is relaxed.

The infra-orbital nerves are the terminal branches of the superior maxillary nerve as it emerges from the infra-orbital foramen, beneath the elevator muscle of the upper lip, and consist of palpebral, nasal, and labial sets.[2] The focus of pain is at the origin of these nerves.[3] Section may be made through the mouth as follows: Recognize the infra-orbital foramen, 2 (Fig. 348), above the second bicuspid tooth and nearly half an inch below the margin of the orbit; raising the upper lip, make an incision along the fold of junction of the lip and maxilla, and continue the dissection to the upper limits of the fossa; now take straight scissors, and continue the dissection upwards to the infra-orbital foramen, which is four or five lines below the orbit in the direction of the first molar tooth; the nerves are readily divided as they emerge from the canal. Section through the skin is made thus: The patient's head being elevated and turned to the other side, recognize the exact position of the foramen by the guides given, and make an incision directly upon it through the skin and fascia.

The superior maxillary nerve, *c* (Fig. 348), is the second branch of the fifth; it passes through the foramen rotundum, across the spheno-maxillary fossa, and traverses the infra-orbital canal in the floor of the orbit and terminates at its foramen. Section is made with a strong tenotome carried along the floor of the orbit in the direction of the nerve; at a depth of two-thirds of an inch cut across the floor of the orbit, which is thin, severing the nerve at 3.[1] Resection may at the same time be made by a transverse incision, one-third of an inch below the border of the orbit, exposing the nerve, which may be seized and drawn out of the canal.[1] In the more formal operations the external incisions may take various forms, as V, +, U, ⊣, the centre being the foramen; the object is to fully expose the foramen, and the margin of the orbit; the canal may be entered by the trephine applied to the antrum,[2] or by raising the tissues covering the floor of the orbit, and entering the posterior part where the canal is covered by fibrous structures. The trephine is required when the nerve is removed at 4 (Fig. 348), the foramen rotundum;[3] the crown should be small and be so placed as to open the antrum at the canal; the lower wall of the canal is broken with the chisel to the spheno-maxillary fossa; the dissection may now be carried on, and the nerve divided at the foramen rotundum with scissors curved on the flat. The canal may be opened by raising the soft parts from the floor of the orbit an inch or more from the orbital edge, and with a hook set at right angles with its shaft, the nerve may be raised and excised an inch.[4] The latter method is to be preferred when the resection is confined to the portion of nerve in the canal.

---

[1] J. M. Warren. [2] Quain's Anatomy. [3] Valleix.

The lingual, or gustatory, nerve, *f* (Fig. 348), one of the special nerves of the taste, supplies the mucous membrane of the mouth, the gums, the sublingual gland, and the papillæ and mucous membrane of the tongue; it is one of the posterior branches of the inferior maxillary branch of the fifth nerve; it is deeply placed, lying first beneath the external pterygoid muscle to the inner side of the inferior dental, then between the internal pterygoid and the inner side of the ramus of the jaw, and crosses to the side of the tongue beneath the stylo-glossus muscle. Resection is made where the nerve lies upon the ramus, 6 (Fig. 348), thus: The mouth opened widely, recognize the pterygo-maxillary ligament below the attachments of which the nerve may be felt on the inner side of the jaw; make an incision backward from the molar tooth over the nerve, an inch in length; the nerve will appear in the wound, and may be picked up and resected; or, draw out the tongue to the opposite side, and make an incision over the sublingual gland, *e* (Fig. 348), continue the dissection through the upper edge of the gland, when the nerve will be exposed and may be excised.[5]

The inferior dental nerve, *d* (Fig. 348), is a branch of the inferior maxillary; it accompanies the inferior dental artery beneath the external pterygoid between the internal lateral ligament and the ramus of the jaw, to the dental foramen, along the dental canal in the maxillary bone, beneath the teeth, to the mental foramen. Resection may be intrabuccal, or by external incision. The intrabuccal operation is as follows:[6] The corner of the mouth being held wide open, make an incision about one inch long, obliquely from within

[1] J. F. Malgaigne.
[2] J. M. Carnochan.
[3] J. R. Wood.
[4] T. G. Morton.
[5] J. Hilton.
[6] Paravicini.

outwards, along the anterior border of the ramus of the jaw through the anterior fibres of the internal pterygoid muscle; tear through the connective tissue between the pterygoid and the periosteum with the finger, when the nerve is easily reached at its entrance into the dental canal. Resection by external incision may be made at any point of the course of the nerve. If the trunk is to be removed before the nerve enters the canal, 5 (Fig. 348), make an incision from the sigmoid notch down to the edge of the jaw, raise and turn back the parotid gland, dissect up the lower portion of the masseter muscle, and remove a section of bone with the trephine; half an inch of the nerve is exposed for resection; the dental artery is liable to be cut, but may be ligated.[1] Resection of any portion of the nerve in the canal may be effected by raising a flap, exposing the bone, and applying the trephine once, twice, or more, and removing the externall wall of the canal.[2] Or, the trephine may be applied at two different points, the nerve trunk cut in them, and that portion then be extracted.[3] The terminal portion of the inferior dental, as it emerges from the mental foramen, 7 (Fig. 348), is distributed to the integument of the chin and lower lip. Resection is made at the foramen thus: Evert the lower lip, and make an incision down to the bone where the lip and gum unite along the groove which separates the alveoli of the canine and first molar teeth; the ends of the divided nerve appear in the wound; seize the proximal end with forceps and draw out of the canal as much as possible.

The facial nerve, 8 (Fig. 348), emerges from the cranium at the stylo-mastoid foramen, and passing through the parotid gland divides into the temporo-facial and cervico-facial branches. Section of the nerve trunk may be made at the stylo-mastoid foramen as follows: Make an incision vertically two inches in length along the anterior border of the process, and of the sterno-mastoid muscle; draw the parotid gland strongly forwards and dissect with the handle of the scalpel to a depth varying from a half to three-fourths of an inch, when the nerve will be found crossing the wound; the internal jugular vein is within a quarter of an inch of the foramen, and in the direction of the wound. The temporal branch may be divided where it crosses the condyle, by an incision slightly oblique from before backwards, starting from the zygomatic arch and terminating above the posterior border of the angle of the jaw; the dissection should be continued through the connective tissue, the parotid gland being drawn down when exposed; the nerve will be found close to the bone and separated from it by connective tissue.

NERVES OF THE UPPER LIMB.

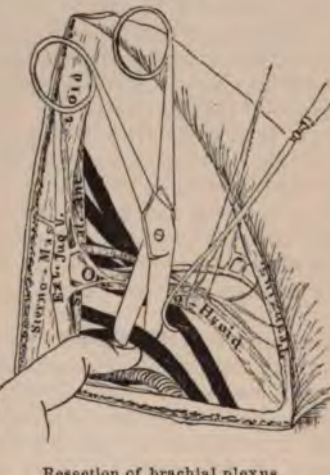
The nerves of the upper limb requiring section are branches of the brachial plexus, which is composed of the four lower cervical and first dorsal nerves.

The brachial plexus may require resection when the neuralgic condition involves a large number of branches. The part most favorably situated for resection is the first combination of nerves in the two cords. These nerves lie above and to the outer side of the subclavian artery, and external to the scalenus anticus muscle. Operate as follows:[1] Elevate the shoulders, drop the head backwards with the face strongly inclined to the sound side; this renders the tissues of the affected side tense, and makes prominent the sterno-cleido-mastoid, the landmark for the first incision; an assistant makes the external jugular prominent by compressing it with a finger applied over the upper margin of the clavicle at its middle, or on a line drawn from the angle of the jaw to the middle of the clavicle; make an incision downwards along the external border of the sterno-cleido-mastoid beginning three inches above the clavicle; from this point make a second incision along the course of the clavicle, giving an L form to the incision of the integument; the length of both incisions must be regulated by the size of the neck of the patient; the next important guide is the tendon of the omo-hyoid muscle, which must be searched for with the finger and handle of the scalpel, the external jugular vein being drawn aside; the posterior belly of the omo-hyoid being recognized is held aside by the finger or ligature; the two cords of the plexus now appear; place a ligature loosely around the upper cord by means of the aneurism needle, or hold it aside with a blunt hook (Fig. 349); pass the index finger of the left hand into the wound and ascertain the exact position of the subclavian artery, which is to be held out of the way and carefully protected; now divide the cord as near the finger of the left hand as possible, with blunt-pointed scissors, and make a second division above the point of section, as far up as practicable, care being taken not to interfere with the scalenus anticus muscle across which passes the phrenic nerve; four-fifths of an inch of the cord may be removed, and the cut ends by retraction separated two and a quarter inches. The outer cord is next resected to the requisite extent. The outer cord may be cut first, and then the inner, by carefully protecting the subclavian artery, as it lies in immediate proximity with the latter cord.

---

[1] J. M. Warren. [2] S. D. Gross. [3] C. Sédillot.

Fig. 349.



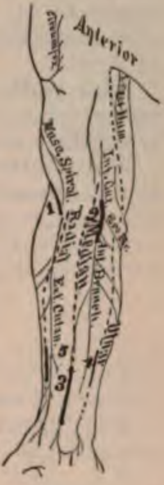
Resection of brachial plexus.

The external or musculo-cutaneous nerve, 1 (Fig. 350) rises from the outer cord of the brachial plexus, passes obliquely between the biceps and brachialis anticus to the outer side of the arm, then becomes cutaneous, and is distributed to the integument of the radial border of the arm. Recognizing the space above the elbow, between the biceps and the anterior border of the supinator radii longus, make an incision two inches in length, oblique from above downwards, and from behind forwards; divide the skin, fascia, and aponeurosis, and the nerve will be exposed, and may be resected to the required extent.

---

[1] H. B. Sands; F. F. Maury.

Fig. 350.

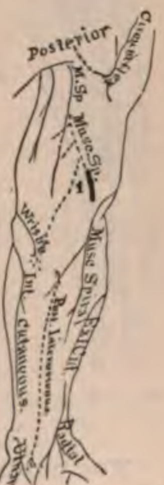


Anterior nerves of arm.

The internal cutaneous nerve, 2 (Fig. 350), is a branch of the internal cord, and is distributed to the internal portions of the forearm. Make an incision obliquely from the lower part of the biceps downward and inward to a point an inch below the internal condyle; cut only through the skin, then open the connective tissue, in which the nerve will be found.

The musculo-spiral nerve, 1 (Fig. 351), is the largest branch of the brachial plexus, and is distributed to the muscles and skin of the posterior surface of the arm, forearm, and hand; it winds around the arm in a groove, with the superior profunda artery, passing from the inner to the outer side of the bone, beneath the triceps muscle; it descends between the brachialis anticus and supinator longus to the front of the external condyle, where it divides into the radial and posterior interosseous.[1] Resection is made above the external condyle as follows: Make an incision three inches in length along the external border of the triceps muscle, and between it and the brachialis anticus. Commencing three inches above the external condyle, and in line with it, dissect the connective tissue with the handle of the scalpel; the nerve is readily exposed close to the bone, and may be resected to any necessary extent. Or the nerve may be exposed above and internal to the external condyle, by recognizing the space between the supinator longus and the brachialis anticus, and making an incision two and a half inches long.

Fig. 351.



Posterior nerves of arm.

The median nerve, 3 (Fig. 350), has been excised for neuralgia in the lower part of the forearm below the origins of the muscular and anterior interosseous branches, and above the origin of the palmar cutaneous branch.[2] Ascertain precisely the margins of the flexor carpi radialis and palmaris longus muscles by extending the hand upon the forearm; make an oblique incision two and a half inches long from over the border of the first to that of the last-named muscle, the lower end of the incision terminating two inches above the line of the wrist-joint; divide the superficial fascia and muscular aponeurosis on a director; seek the nerve in the intermuscular space, and expose it at the lower end of the cut, where it emerges from beneath the oblique fleshy fibres of the flexor sublimis digitorum; raise this muscle and the nerve will be exposed the length of the cut.

---

[1] H. Gray.

[2] J. H. Brinton.

The radial and ulnar nerves may be resected by the same operative procedures as are taken in ligature of the respective arteries which they accompany, 4, 5 (Fig. 350).

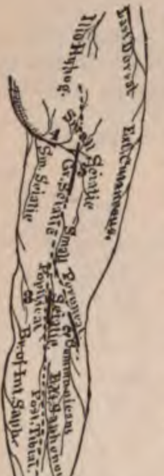
The digital nerves[1] may be excised by an incision on the inner or outer aspect of the first phalanx of the finger; in severe cases of neuralgia, resection should be performed on both sides of the finger; subcutaneous section of these nerves may be made by passing a narrow-bladed knife on both sides.

NERVES OF THE LOWER LIMB.

The nerves of the lower limb requiring section are branches of the lumbar and sacral plexus.

The great sciatic, 5 (Fig. 352), the largest nerve of the sacral plexus, supplies largely the integument of the leg. Place the patient on the abdomen; recognize the gluteal fold, and the point of junction of the flexor muscles of the thigh, make an incision three inches long through the skin, fascia, and connective tissue; with the finger and handle of the scalpel expose the nerve, and resect to the required extent.[2]

Fig. 352.



Posterior nerves of leg.

The popliteal nerve, 3 (Fig. 352), the continuation of the great sciatic, may be resected at the interval between the flexor muscles above the popliteal space; the incision being made through the skin and fascia, the nerve should be uncovered by dissection with the finger and handle of the scalpel, and an inch and a half removed.

The perineal nerve is the larger branch of the pudic; it is distributed to the organs of generation. It has been divided for severe vaginal neuralgia successfully,[3] as follows: with the finger introduced deeply into the vagina, recognize the nerve, which feels as a hard cord and is very sensitive on pressure; make a deep vertical incision, which will bring the nerve into view; remove it to the extent of an inch.

The small sciatic nerve, 4 (Fig. 352), has been excised[4] for multiple neuroma successfully, as nearly as possible to its origin, by an oblique incision almost in the direction of the gluteal fold; the portion of nerve was removed from under the edge of the gluteus maximus.

The peroneal or external popliteal nerve is, 2 (Fig. 352), given off from the popliteal nerve and passes along the inner margin of the tendon of the biceps, or external hamstring muscle. It is excised as follows: Make an incision two or three inches long on the inner border of the biceps tendon, through the integument and superficial fascia; the nerve will be found close to the tendon and may be easily excised to the extent of an inch or more.

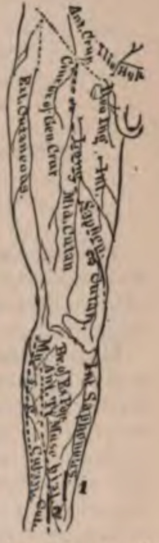
---

[1] J. M. Warren. [2] T. Billroth. [3] T. G. Morton. [4] Kosinski.

The anterior and posterior tibial nerves, 2 (Fig. 353), 6 (Fig. 352), accompany their respective arteries in such proximity that the incisions for the ligature of these arteries may be adopted for the resection of the nerves.

The internal saphenous nerve, 1 (Fig. 353), is a branch of the anterior crural, and distributed to the integument on the inner side of the leg; it lies superficially in immediate relations with the internal saphenous vein. Make an incision along the track of the vein made prominent by pressure above; the nerve lies immediately behind the vein; if necessary, the vein may also be divided and tied. It (3, Fig. 353) may also be resected where it emerges from beneath the sartorius muscle at the inside of the knee. Recognize the sartorius and gracilis muscles at the inside of the knee, and the trunk of the internal saphenous vein by compressing it above; make an incision two inches long in the course of the vein through the skin and fascia, draw the vein aside, and the nerve will be found as it escapes from the deep aponeurosis and may be resected to the desired extent.

Fig. 353.



Anterior nerves of leg.

The external saphenous nerve, 1 (Fig. 352), a branch of the lumbar plexus, descends along the fibular side of the posterior surface of the leg in connection with the vein of the same name. Make an incision along the vein, distended by pressure above, behind the malleolus, or external to the tendo Achillis; carefully turn the vein aside and the nerve will be exposed.

The internal plantar nerve has been successfully resected[1] for tetanus caused by injury of the digital branches. The nerve is the larger division of the posterior tibial and accompanies the internal plantar artery; from the point of division of the posterior tibial nerve between the internal malleolus and heel it is directed forwards under cover of the abductor of the great toe, passing between that muscle and the short flexor of the toes. Make an incision along the internal margin of the foot, commencing at the anterior border of the heel about one-fourth of the distance from the inner to the outer margin, forwards two inches; this incision will be along the external margin of the abductor pollicis; carefully open the space, between this abductor and the short flexor and the artery will be recognized with the nerve accompanying it, which may be resected an inch or more.

---

[1] G. E. Foster.

VI.

THE TEGUMENTARY SYSTEM.

THE SKIN; THE HAIR AND GLANDS; THE NAILS.

CHAPTER XXXII.

INJURIES AND DISEASES OF THE TEGUMENTARY SYSTEM.

I. INJURIES OF THE SKIN.

Though the skin consists of several separate tissues, as the epidermis and papillary body, the corium and subcutaneous areolar tissue, and glands, they are all so implicated in injuries, and the various results which follow, that they cannot practically be isolated.

Contusion, without external wound, is the common bruise of skin and subcutaneous tissue; if slight, the textures suffer only shaking or iarring, followed by rupture of bloodvessels and effusion of fluid; if severe the damaged structures are broken, and there may be visible ruptures of soft parts, especially splittings of the subcutaneous tissue, and separations of it from the fasciæ; in extreme cases the parts are thoroughly crushed. First, there is some depression or indentation, with softening of the injured tissues; then swelling succeeds, due partly to extravasation, but much more to the rapid afflux of blood and exudation from the vessels. In general the treatment, when the effusion is going on, should be ice, the limb or part being suitably elevated. Stimulating applications, as alcohol and water, camphor spirits, or arnica, are useful. If there is much breaking and crushing of tissues the parts should be kept warm to prevent sloughing, with wrappings of cotton-wool soaked in oil, or linseed poultices; extreme cases should be treated as for traumatic gangrene; if the blood remain in large quantities, friction and kneading may promote absorption by diffusing it in the tissues; if it still remain, evacuate it with antiseptic precautions, and treat the cavity as an open abscess.

Hæmatomata are collections of blood in the tissues involved in the contusions. They appear quickly after the injury as distinct fluctuating swellings, and may be circumscribed or diffuse. The effusion usually occurs in the subcutaneous cellular tissue, but effusions of blood in the scalp, cephalhæmatomata, may form beneath the skin or below the aponeurosis. The blood may remain fluid, or coagulate, or suppuration may occur. The treatment should be the same as for contusions, except when suppuration begins, or the tumor is so situated as to be a serious inconvenience, as on the head. In these cases the cavity should be freely opened, all of the blood carefully removed, dead tissues and granulations cut or scraped away, the internal surfaces cleansed with weak carbolic solutions, a drainage tube introduced, and the wound accurately closed and dressed with antiseptic materials.

Incised wounds are made with sharp instruments, as knives, sabres, etc.; the edges are smooth-cut, regular, the tissue unchanged. Pain follows the injury at once, varying with the nerve supply of the part and the sensitiveness of the patient; the feeling is that of a peculiar burning or smarting; hemorrhage is the second immediate symptom, its extent depending upon the number, size, and variety of the vessels divided; if the capillaries alone bleed, the hemorrhage quickly ceases; if an artery is cut, the bright red blood flows in a stream, often pulsatile; hemorrhage from the veins is characterized by the steady flow of dark blood. Incised wounds of the skin only vary somewhat in different parts of the body. Wounds of the scalp are surrounded by hair, the skin is very vascular, and rests upon a firm aponeurosis. Though these wounds are liable to be followed by erysipelas when treated by the old methods, and hence the danger of such an irritant as the suture, yet if antiseptic measures are thoroughly followed, they may be safely closed with sutures like other wounds. The same remark applies to wounds of the face.

The treatment of incised wounds of the integument only, should be the same in all parts of the body. Proceed as follows: Arrest the bleeding from every point which can be seized with forceps by applying the finest catgut ligatures, or resort to torsion; wash the neighboring parts with soap and water and shave off cleanly all hairs, cleanse the same surfaces with the weak sublimate solution; examine minutely the entire surface of the wound, remove every particle of foreign matter and dead tissue; cleanse the wound with a douche of sublimate solution which is to be repeated at intervals during the suturing. Use the continued suture, closely applied, and close the entire wound; for drainage a few threads of catgut or horse-hair may be placed in the most dependent angle. Dust the surface with iodoform and apply iodoform pads with bandage. If the wound gaps widely use the deep and continuous suture.

The following method of dressing scalp wounds is recommended:—[1]

The wound and bloody hair are thoroughly cleansed with a douche of the hydronaphthal solution, next the hair is carefully cut with scissors for about an inch around the margins of the wound, after which it is cleanly shaved; the wound is now again cleansed with the hydronapthal, all clots and foreign bodies being removed, and careful examination for fracture made; no fracture being found, lay ten or twelve horse-hairs along the bottom of the wound, and stitch the edges with catgut sutures leaving the horse-hairs projecting about three-fourths of an inch beyond the ends of the wounds and thus acting as a drain; wash the wound again with the hydronaphthal, and powdered iodoform lightly dusted over the line of the sutures, upon which are applied a few layers of iodoform gauze, over this place a large compress of absorbent gauze, extending several inches beyond the wound on every side, the whole being held in place by a bandage. As a rule primary union has taken place at the end of two days except at the end where the drain protrudes; now, remove all of the horse-hairs but three or four, irrigate with the hydronaphthal solution, and apply the same dressing; in two or three days more remove the remaining horse-hairs; the cure is complete in general within seven days.

---

[1] C. R. Parke.

Contused and lacerated wounds[1] may be simple solutions of continuity, or be attended with loss of substance. The borders are generally uneven tags, and not unfrequently large flaps of the soft parts hang in the wound, having a bluish-red color; the skin for some distance is often detached from the fascia, especially if the contusing force was combined with tearing and twisting; tendons are torn or pulled out; the skin-wound usually gives no means of judging of the extent and depth of the contusion. The pain is not great, especially if parts have been crushed; the bleeding is slight, and not in a stream; even if large arteries and veins are involved, the blood will ooze from the wound. If the case is seen early the treatment should be on the same general principles as that of incised wounds. Cleanse all the surrounding parts with soap and water, and shave the hairs; now cleanse the wound of all foreign matters, using the hot sublimate solution; explore all recesses and irregularities into which foreign bodies may have been forced; cut away all dead or badly damaged tissue; arrest all bleeding by the catgut ligature. If the wound can be closed, employ drainage where fluids may collect, and apply the continuous suture, using the sublimate solution at intervals. If it cannot be closed, dust the surface lightly with iodoform, and apply iodoform gauze pads.

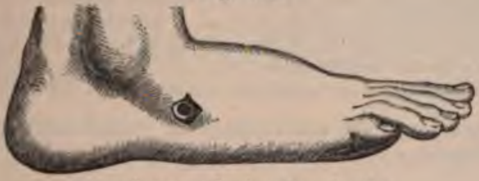
Gunshot wounds[2] vary in extent and severity according to the nature of the missiles and the conditions under which they expend their force. When a cannon-ball at full speed strikes in direct line a part of the body it carries away all before it; in case the force of the cannon-shot is partly expended, the extremity or portion of the trunk may be equally carried away, but the laceration of the remaining parts of the body will be greater, and the surface of the wound will be less even; if the speed be diminished so that the projectile becomes spent, there will not be removal of the part of the body struck, but the external appearance will be limited usually to ecchymosis and tumefaction, without division of surface. Large fragments of heavy shells generally produce immense laceration and separation of the parts against which they strike, but do not carry away or grind, as round shot. Small projectiles, with force enough to penetrate the body, leave one or more openings, the external appearances of which also vary according to their form and velocity; when the musket-ball strikes at a distance from the weapon by which it was propelled, but still preserves great velocity, an opening is observed, irregularly circular, with edges generally a little torn, the whole wound is slightly inverted, and there may be darkening of the margin, of a livid purple tinge, from the effects of contusion, or it may be simply dead-like and pale (Fig. 354). Should the ball have passed out, the wound of exit will be probably larger, more torn, with slight eversion of its edges, and protrusion of the subcutaneous fat, which is thus rendered visible (Fig. 355). These appearances are the more easily recognized the earlier the wound is examined, and are more obvious if a round musket-ball has caused the injury than when it has been inflicted by a cylindro-conoidal bullet.

---

[1] T. Billroth.

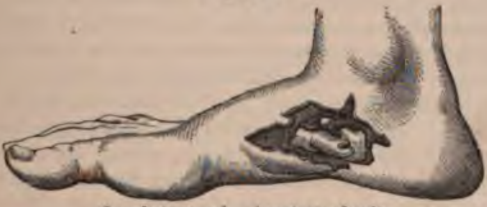
[2] T. Longmore.

Fig. 354.



Gunshot wound. Aperture of entry.

Fig. 355.



Gunshot wound. Aperture of exit.

A musket-ball ordinarily causes either one wound, as when after entering it lodges, or, as sometimes happens, from its escaping again by the wound of entrance; or two wounds, from making its exit at some point remote from the spot where it entered; but occasionally leads to a greater number of openings; this last result may happen from the ball splitting into two or more portions within the body, and causing so many wounds of exit; the number of wounds made by one ball may be increased by its traversing two adjoining extremities of the same person, or even distant parts of the body, from accidental relative position at the time of the injury. The appearances of wounds resulting from penetrating missiles of irregular forms, as small pieces of shells, musket-balls flattened against stones, and others, differ from those caused by ordinary bullets in being accompanied with more laceration, according to their length and form; being usually projected with considerably less force than direct missiles, such projectiles ordinarily lead to only one aperture, that of entrance.

A wound by musket-shot is attended with an amount of pain which varies very much in degree according to the kind of wound, and condition of mind, and state of constitution; sometimes it is described as a sudden, smart stroke of a cane; in other instances as the shock of a heavy, intense blow; occasionally the pain will be referred to a part not involved in the track of the wound; when a ball does not penetrate, but simply inflicts a contusion, the pain is described as more severe than where an opening has been made by it. As a general rule, the graver the injury, the greater and more persistent is the amount of shock. In the examination of these wounds it is important to place the patient, as nearly as can be ascertained, in a position similar to that in which he was, in relation to the missile, at the time of being struck.

When only one opening has been made by a ball, it is to be presumed that it is lodged somewhere in the wound, and search must be made for it accordingly. But even where two openings exist, and evidence is afforded that these are the apertures of entrance and exit of one projectile, examination should still be made to detect the presence of foreign bodies. Portions of clothing, and other harder substances, are not unfrequently carried into a wound by a ball; and, though it itself may pass out, these may remain behind, either from being diverted from the straight line of the wound, or from being caught and impacted in the fibrous tissue through which the ball has passed. The inspection of the garments worn over the part wounded may often serve as a guide in determining whether foreign bodies have entered or not, and, if so, their kind.

Of all instruments for conducting an examination of a gunshot wound, the finger is the most appropriate.

It should always be first made completely aseptic by washing, cleaning the nail, and submersion in bichloride or carbolic solutions.

By its means the direction of the wound can be ascertained with least disturbance of the several structures through which it takes its course. The index finger naturally occurs as the most convenient for this employment; but the opening through the skin is sometimes too contracted to admit its entrance, and in this case the substitution of the little finger will usually answer all the purposes intended. When the finger fails to reach sufficiently far, owing to the depth of the wound, the examination is often facilitated by pressing the soft parts from an opposite direction towards the finger-end. Where the finger is not sufficiently long to reach the bottom of the wound, even when the soft parts have been approximated by pressure from an opposite direction, and when the lodgment of a projectile is suspected, a probe is the best substitute. It may be single, *n* (Fig. 356), or jointed, *l*, *m*, *n*. It must be employed with great nicety and care, for it may inflict injury on vessels or other structures which have escaped from direct contract with the ball, but have returned, by their elasticity, to the situations from which they had been pushed or drawn aside during its passage. But frequently it is difficult to determine whether any solid body felt with the probe is lead, and for this purpose the end of

Fig. 356.

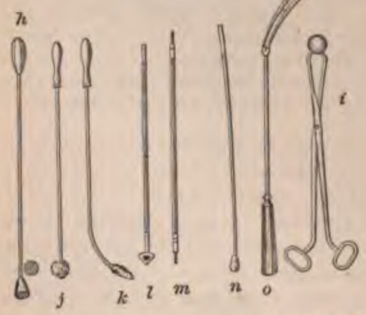
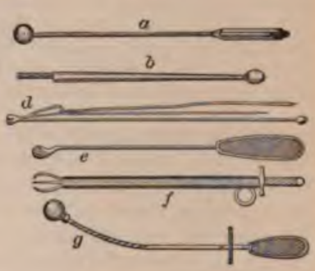


Fig. 357.



Bullet probes and forceps.

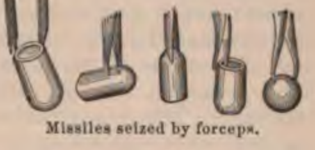
the probe may be of porcelain, which is marked only by lead,[1] *a* (Fig. 357), or which has a burr, *h*, *j* (Fig. 356), which will chip off fragments of lead when rotated on the ball. An electrical probe has been devised[2] which is very delicate in its action.

As soon as the presence of a ball or other foreign body is ascertained it should be removed; if it be lying within reach from the wound of entrance it should be extracted through this opening by means of some of the various instruments devised for the purpose (*i*, Fig. 356, *e*, *f*, Fig. 357).

The way to the removal of a bullet may often be smoothed by judiciously clearing away the fibres, among which it is lodged, during the examination by the finger; and sometimes, by means of the finger in the wound, and external pressure of the surrounding parts, the projectile may be brought near to the aperture of entrance, so that its extraction is still further facilitated. Such foreign substances as pieces of cloth can usually be brought out by the finger alone, or by pressing them between the finger and a silver probe inserted for the purpose. Sometimes a long pair of dressing-forceps, guided by the finger, is found necessary for effecting this object. Caution must be used in employing forceps, where the foreign substance is out of sight and of such a quality that the soft tissues may be mistaken for it. It does not often happen that it is necessary to enlarge the opening of wounds to remove balls, although a certain amount of constriction of the skin may be expected from the addition of the instrument employed in the extraction; but if much resistance is offered to their passage out, it is better to divide the edges of the fascia and skin to the amount of enlargement required than to use force. In removing fragments of shells or detached pieces of bone, the fascia and skin have almost invariably to be divided to a considerable extent.

In instances where the foreign body has not completely penetrated, but is found lying beneath the skin away from the wound of entrance, an incision must be made for its extraction; before using the knife, the substance to be removed should be fixed *in situ*, by pressure on the surrounding parts; in the instance of a round ball, the incision should be carried beyond the length of its diameter; an addition of half a diameter is usually sufficient to admit of the easy extraction of the ball. In removing conical balls, slugs, fragments of shells, stones, and other irregularly-shaped bodies, the surgeon cannot be too guarded in arranging so that the fragment will present its long axis in line with the track of the wound. To effect this object, it is necessary to seize the missile in such manner as to bring its long axis to correspond with that of the track of the wound (Fig. 358).

Fig. 358.



Missiles seized by forceps.

When there is reason for concluding that a ball or other foreign body has lodged, but after manual examination, and observation as well by varied posture of the part of the body supposed to be implicated as by indications derived from the patient's sensations, effects of pressure, or injury to nerves, and all other circumstances which may lead to information, the site of lodgment cannot be ascertained, the search should not be persevered in to the distress of the patient. Neither, although the site of lodgment be ascertained, if extensive incisions are required, or if there is danger of wounding important organs, should the attempts at extraction be continued. Either during the process of suppuration, by some accidental muscular contraction, or by gradual approach towards the surface, its escape may be eventually effected; or, if of a favorable form, and if not in contact with nerve, bone, or other important organ, it may become encysted, and remain without causing pain or mischief.

---

[1] E. Nélaton.

[2] M. Trouvé.

. All foreign matters being removed, the wound must be cleansed with the bichloride solution to its deepest recesses, suitable drainage provided, a position of perfect rest secured, and iodoform dressings applied. When much local inflammation has set in, and when there is much constitutional fever, even without unusual local irritation, the non-evaporating or warm applications will be found to be the most advantageous. If suppuration occur, care must be taken to prevent the accumulation of pus, lest it burrow, and sinuses become established, not an unfrequent result of want of sufficient caution in this regard; if much tumefaction of muscular tissues beneath fasciæ occurs, or abscesses form in them, free incisions should be at once made for their relief with antiseptic precautions.

Poisoned wounds are wounds inoculated with a poison capable of producing either (1) fever and its complications; or (2) symptoms of specific general poisoning; or (3) definite diseases.[1] (1) The first variety of poison is developed in decomposition of animal matters, and appears in butchers, cooks, and those engaged in dissections.

Ordinary dissection wounds are generally harmless, unless the person is very susceptible; it is in the bodies of those dead of pyæmial diseases, as puerperal peritonitis, that the poison is especially virulent; in these cases it may enter the system even through the unbroken skin.[2]

The effects of the poison may appear in various degrees of severity; (*a*) there may be a slight induration of the part, with moderate pain, followed by a dry scale which recurs as often as it is removed; the epidermis thickens over it and forms a painful, wart-like nodule—the anatomical tubercle;[3] (*b*) there may be an inflammation of the lymphatic vessels and axillary glands terminating in abscesses; (*c*) the poison may develop an acute septicæmia and rapidly prove fatal;[4] (*d*) the course of the poison may be chronic, involving the glands, and inducing wide-spreading phlegmonous inflammations and abscesses.[2] The treatment at the outset should be irrigations of the wound with cold water, or sucking it with the mouth; immediate cauterization is unadvisable,[5] unless the wound is free, and the poison is from a recent puerperal case, when nitrate of silver, chloride of zinc, or even nitric acid may be applied.[6] If lymphangitis appear, place the limb in a quiet position and apply a lotion of opium and lead. If abscesses form, evacuate them early, disinfect the interior with bichloride solutions, give opium to alleviate pain, and wine and nourishing food for the general strength. If the disease run an acute course, this treatment must be much more energetically enforced. (2) The second variety of poison emanates from venomous animals, as wasps, hornets, bees, snakes, scorpions. The effects of the sting of wasps and bees rarely extend beyond the immediate vicinity of the injury, and require at the most only the application of vinegar or ammonia in solution, and simple domestic remedies, as bread-and-water poultices. The same treatment may be pursued in the bites of snakes, unless they are known to be dangerously poisonous, as that of the rattlesnake; in such a case prompt action is required, namely, a ligature should be tied so firmly around the part as to interrupt all circulation; if it is a finger amputate at once; otherwise excise the wound thoroughly, and suck the blood from the part; finally, cauterize the surface. The subsequent treatment will depend upon the symptoms as they develop. (3) The third[1] form of poison causes specific diseases, and is derived from the secretions of animals affected with glanders and hydrophobia. Glanders in man results from inoculation of a wound with the pus from the nares of the affected horse; it excites severe and wide-spread inflammation, with all the symptoms of acute septicæmia. The treatment must be directed by the symptoms. Hydrophobia results from the inoculation of a wound by the saliva of a rabid animal, as a dog or cat; the bite usually heals readily, but it is more favorable if the wound suppurates freely; the disease rarely appears under six weeks, and frequently later. The treatment should be cauterization of the wound, and promotion of suppuration; after the appearance of constitutional symptoms there is no hope. Excision of the cicatrix may be resorted to, though amputation even has proved useless.

---

[1] T. Holmes.
[2] Sir J. Paget.
[3] S. Wilkes.
[4] T. Billroth.
[5] Sir J. Paget; T. Billroth.
[6] T. Bryant.

The most important measure is prevention by inoculation,[2] the intrinsic value of which has not been as yet determined, though the evidence is strongly in its favor.

Frost-bite,[1] or chilling of parts by cold, occurs more often when cold is accompanied with moisture; closely-fitting clothes, which impede circulation, increase the predisposition. It may be so slight as to cause simple numbness of the fingers or toes, and whiteness of the skin; when these symptoms subside the skin becomes red, the fingers swell, and there is a peculiar itching and prickling; no other treatment is required than rubbing the parts and restoring the circulation by degrees; the redness may remain long after recovery, and even become permanent. A severe form appears in the rising of vesicles with complete loss of sensation; there is now danger of mortification. The treatment consists in a very gradual change to a higher temperature, snow or ice may be rubbed upon the parts, or cloths dipped in ice-water applied. Belladonna and soap liniment, equal parts, allay itching. There may be the formation of eschars; the parts are then quite destroyed by the cold, and sloughs form as in severe burns. Boracic acid ointment is a useful application. The treatment is, in general, the same as in the milder cases of burns, but the ulcers which result from the slough require a long period in which to cicatrize.

Chilblains, pernioes, result from repeated freezings, causing paralysis of the capillaries with serous exudations in the cutis.[1] There may be simple congestion attended with itching, alternating with extreme tenderness; or there may be vesication, and, in extreme cases, death of the skin or areolar tissue; usually there is a daily attack of congestion occurring in the afternoon or evening, with increased heat and swelling, followed by itching, then swelling, and finally, soreness, aching, and extreme sensibility.[1] In treatment, direct loosely fitting and warm coverings for the parts, and applications which relieve the local distress; the latter must be selected by the experience of each patient. Those generally useful, where the skin is unbroken, are stimulating liniments, as, camphorated oil; equal parts turpentine and copaiba; tr. iodine; tr. cantharides 1 part, and soap liniment 3 parts; solutions of nitrate of silver; to relieve itching, cold water, or hot mustard water are most effective; if there are vesicles, collodion is very serviceable; for ulcers, boracic-acid ointment may be employed.

---

[1] T. Billroth.

[2] Pasteur.

Burns and scalds may be of different degrees of severity, but the risk to life is to be measured by the extent of surface involved; they are most serious to the young and the old, but at all ages extensive burns are to be feared: first, from their immediate depressing effects; second, from inflammatory complications; and, third, from suppuration; when the injury is over the thoracic region, chest complications are liable to follow; if over the abdomen, dangerous intestinal affections may appear.[2] The several grades of burns are as follows: (1) They may be so slight as to cause simple redness of the skin, due to a dilatation of the capillaries, and slight exudation of serum in the tissue of the cutis; there is a mild grade of inflammation, followed in many cases with detachment of the epidermis; the pain is severe for a few hours. (2) The burn may be deeper, followed by the formation of vesicles, due to the rapid escape of fluid from the capillaries between the mucous and horny layer.[3] If this burn is quite limited, recovery is rapid and satisfactory; but if spread over a large surface, the shock and collapse may be severe, and recovery uncertain. (3) In this form the destruction is deeper and the eschars, or sloughs, result with varying degrees of suppuration. If the surface involved is considerable, reaction will probably not occur, and death will soon follow. The treatment should be directed first to the shock and depression, which may be mitigated by external warmth with hot drinks, stimulants, and opium to relieve pain; next, remove the clothes, with care to avoid tearing off the vesicles. The antiseptic treatment is as follows:[4] If a small portion of the body has been burned, as, for instance, the forearm and hand, the plan to be carried out would be as follows: (1) Anæsthetize the patient. (2) Pull off all of the cuticle which is loose, and all that has been raised in blebs and vesicles. (3) Lay the arm on a towel which has been wrung out in bichloride of mercury solution, 1 to 2000, and carry a rubber blanket underneath all; arrange the rubber blanket in such a way that irrigating fluids shall run into a pail placed for their reception. (4) Scrub the burned area and the skin in its vicinity very thoroughly with a soft brush and at the same time bathe the parts copiously with bichloride of mercury solution, 1 to 2000, or with a solution of salicylic and boracic acids in the proportion of one grain of the former and six grains of the latter to the fluidounce of water. (5) Cover the burned surface evenly with strips of protective oiled silk which have been stored in an antiseptic solution. (6) Sprinkle iodoform along the margins of the strips of protective. (7) Place several layers of carbolized or sublimated gauze over the protective and cover still further with a thick wadding of borated cotton placed between layers of antiseptic gauze. (8) Apply snugly a carbolized roller bandage. The dressing should not be disturbed until the eighth day, and when it is removed it will be found that everything is completely healed and no further treatment is necessary.

---

[1] T. Smith. [2] T. Bryant. [3] T. Billroth. [4] R. T. Morris.

The brush which we use must be first washed in an antiseptic solution, and the surgeon's hands must be most carefully prepared before he touches the case.

If the true skin is destroyed through a part of its thickness, the following course is the best one to be pursued: (1) If the burn is small, including a few square inches only, apply the antiseptic dressing which is used for limited burns of the second degree. (2) Do not remove the dressings until the end of the third week, and then if the slough has not been absorbed pull it away and irrigate the granulating surface with an antiseptic fluid. (3) Hurry the reparative processes by doing a plastic operation or by skin-grafting; and when the latter is to be done, graft according to the following directions: Shave and scrub with an antiseptic solution any portion of healthy skin which you may choose. Raise small pieces of cuticle from the cleansed skin, on the point of the needle, and cut them away with a sharp scalpel. Place these severed pieces of cuticle near the margins of the granulating surfaces. Carefully lay a piece of antiseptically prepared protective oiled silk over the grafted area. Over the protective, place eight or ten layers of sheet lint, which have been wrung out in a saturated solution of boracic acid. Cover all with a piece of gutta-percha tissue or any other water-proof material. Change the dressing on the third or fourth day, and after washing the granulating surface gently with a warm saturated boracic-acid solution, add more grafts and dress as before. If no attempt is made to improve upon this method of grafting almost every little piece of cuticle will "catch." If the true skin is entirely destroyed the burn should be treated by the dry method from the very first: (1) Rub the burned surface full of subnitrate of bismuth and iodoform, and continue doing this as long as any moisture remains. (2) Cover with a single layer of soft cloth or sheet lint. (3) When the dead skin has become dry and hard, and begins to slough away, aid the separation by trimming with scissors, and complete the case as if it were one of the third degree. In cases where a very large surface of the body has been burned to the second degree, it is often impossible to apply the thoroughly antiseptic dressing which has just been described, and the subnitrate of bismuth treatment, which stands next in value, should be applied as follows: (1) Anæsthetize the patient with chloroform. (2) Remove all clothing, and whatever may adhere to the burned surfaces. (3) Wash all of the injured area with an antiseptic solution. (4) Pull away all loose cuticle, and as fast as it is removed sprinkle the parts beneath thickly with subnitrate of bismuth. (5) Cover lightly with a single layer of soft cloth or sheet lint. (6) Remove the cloth covering once or twice daily, and wherever any of the subnitrate of bismuth has been loosened by the discharge, sprinkle more of the powder on the place.

Extensive burns are almost invariably found to be associated with burns of the second degree, and it will be best to combine two methods of dressing. At first apply the same dressing as in limited burns of the second degree, and allow it to remain undisturbed until an odor of beginning decomposition is noticed. This odor will first appear about the twelfth day, and calls for immediate attention. A serous discharge may make its way through the dressings before we wish to change them, but by sprinkling iodoform over the moist place and by bandaging on an additional wad of borated cotton, or sublimated gauze, or a peat bag, we can shut off the entrance of spores which would cause early decomposition. When it becomes necessary to change the dressing, remove everything under antiseptic irrigation and sprinkle the granulating surface thickly with subnitrate of bismuth. Where sloughs remain attached rub them full of iodoform and subnitrate of bismuth, and then allow the whole wound to dry; a single layer of sheet lint being all that is required for extra covering. The sloughs will soon become of a horny consistence and they may be trimmed off from time to time. Bismuth should be sprinkled over the exposed surface beneath as fast as the sloughs are removed. Do plastic operations or grafting early, and give the patient stimulating diet.

The methods formerly pursued were usually as follows: Puncture the blisters at the most depending part to allow the escape of the fluid without the removal of the pellicle. Soothe the irritated parts and protect them from the air, and for this purpose the following remedies were used, according as they were at hand: Equal parts of linseed oil and lime-water on lint, and covered with cotton-wool; carbolized oil; a complete covering with flour; white lead in the form of paint;[1] zinc ointment on lint; for the separation of sloughs, the most important is the carbolic-acid dressing, as follows: Carbolic acid, one ounce to a pint of olive or linseed oil, or an ointment made of carbolic acid ʒiv, lard ℥iv, and castor oil ℥j;[2] to the other surfaces involved apply the oil and lime-water, or zinc, or creasote ointment gtts. x to lard an ounce; or a lotion of tr. iodine ʒj to water one pint.

II. DISEASES OF THE SKIN.

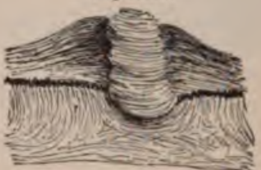
The epidermis and papillary body form the more superficial portion of the integument, the former being an insensible covering of flattened cells, while the latter is richly supplied with vessels and nerves, and reacts to stimulants by hyperæmia and inflammation; the two constitute a vegetable whole, the latter being the matrix of the former, through the constant supply of young cells; a morbid sub-activity of this process results in various hypertrophies of these tissues.[3]

The callosity is a circumscribed thickening of the horny layer of the epidermis, and consists of many strata of epidermic scales superimposed on one another, the deeper resting on the rete mucosum; it increases gradually by the continual addition of new epidermic tissue from below, and finally develops into a plate which steadily becomes more elevated; its consistence depends upon its moisture, and varies from the elastic and flexible to the horny and brittle; it appears on parts of the skin exposed to a frequently recurring but not continuous pressure, and which rests on bone, as the heads of the metacarpal and tarsal bones; they sometimes form as large and painful plates on the sole or palm.[1] The treatment consists in removal of the growth and prevention of its recurrence; after prolonged soaking in hot water, apply glacial acetic acid, or nitrate of silver, and detach the plates which form;[2] protect the part from pressure of the substance which caused the original thickening.

---

[1] S. D. Gross. [2] J. Lister. [3] E. Rindfleisch; F. Hebra.

Fig. 359.



Structure of a corn.

The corn (Fig. 359) is a callosity so modified by the yielding of the deeper parts to the external pressure that the deep layers assume the form of a nail (clavus) with its point penetrating the cutis; the external elevation is small, but the swelling from the under surface of the thickened horny layer forms a truncated cone with the axis at right angles to the surface of the skin into which it has penetrated for some distance; like the callosity, it varies in consistence with the degree of moisture, on exposed surfaces being hard, but, between the toes, soft; a bursa may form when the corn penetrates the skin.[3] The treatment is the same as for a callosity.

Warts (verruca) are overgrowths of the epidermis, in which the papillary body shares more or less; the common hard wart consists of a circular group of elongated papillæ, with their free extremities slightly enlarged and bulbous, their vessels dilated and extending close up to the epidermic covering.[3] The treatment should be, (1) an effort to turn the wart out by pressure with the finger-nail, which frequently succeeds with dry warts on the face and moist warts on the genitals;[1] (2) excision with knife or curved scissors, and cauterization of the base with chloride of zinc; (3) destruction by caustics, as chloride of zinc, nitric acid; (4) desiccation by applications of tr. iodine or acetic acid.

The cutaneous horn results from hypertrophy of a group of papillæ; in its growth it may involve hair sacs and contain sebaceous cysts.[3] The treatment is extirpation.

Erysipelatous inflammation is located chiefly in the papillary layer and in the rete Malpighii; any part may be attacked, but it is most frequent in the head and face; the local symptoms are great redness and œdematous swelling of the skin, pain on being touched, and high fever; it lasts from one day to three or four weeks. The treatment is laxatives to improve the digestive organs; then give tonics, as quinine and iron; good diet; locally, light scarifications are often useful, followed by lead and opium lotions; if pus form it must be evacuated.

The furuncle, boil,[4] seems to have its origin in the death of a small portion of skin, or perhaps of a cutaneous gland, which becomes the centre of an inflammation; by infiltration with plastic matter the tissue of the cutis partly turns to pus and partly becomes gangrenous; the peculiarity of this form of inflammation is, that it shows no tendency to spread, but remains circumscribed, and terminates in the detachment of the central dead tissue; regions where the secretions of the cutaneous glands are particularly strong are predisposed to furuncles, as the axilla, perineum; they occur more often in the emaciated and feeble, but may appear in the robust and well-fed.

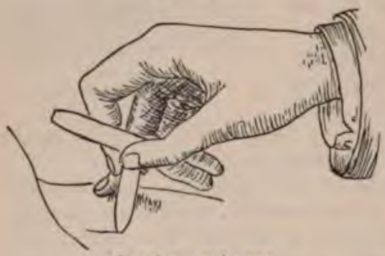
---

[1] F. Hebra. [2] Ormsby. [3] E. Rindfleisch. [4] T. Billroth.

There are also constitutional conditions and diseases which dispose to the formation of boils, creating a diathesis, furunculosis, which may prove very exhausting, especially to children and old persons.

The disease appears first as a red and rather sensitive nodule in the skin, size of a pea or bean; soon a small white point forms on its apex; the swelling spreads around this centre, and usually attains the size of a dollar; towards the fifth day the central white point becomes loosened, and is evacuated as a plug with pus mixed with blood and shreds of tissue; suppuration ceases in three or four days, and the cavity cicatrizes. The abortive treatment with ice is not advisable; warm, moist applications should be made, as poultices, to hasten suppuration, and an early opening be made to relieve tension and evacuate the contents. Select a lancet having a fine point and a broad, sharply-cutting shoulder; plunge the point nearly vertically to the surface (Fig. 360) so deeply as to reach the pus, and then cut outwards. To the debilitated, give quinine, iron, wine, nutritious foods.

Fig. 360.



Opening an abscess.

Carbunculous inflammation, anthrax,[1] anatomically resembles several furuncles lying close together, but the process is more intense and inclined to spread; their chief seat is the hard skin of the back, especially in old people; they first appear like the furuncle, but soon a number of white points form near each other, the swelling, redness, and pain increase, and the carbuncle may attain the size of a soup-plate, while plugs and gangrenous shreds are detached, until the skin appears perforated like a sieve; the process is almost always limited to the skin and subcutaneous cellular tissue, fasciæ, muscles and arteries rarely being destroyed; after the separation of the cellular tissue and arrest of the process, luxuriant granulations appear and healing progresses favorably. Carbuncle of the back is tedious and painful, but rarely causes death. The disease may, however, attack other parts as the lips, or cheeks, or head, and prove rapidly fatal; in many cases of malignant carbuncle the inflammation extends to the cranial cavity often along the sheaths of veins; but in other, and the more quickly fatal, cases, the brain is not affected, and the probability is that there is a rapidly-occurring decomposition of the blood of which the carbuncle may be the cause or the result.

This decomposition may have its origin in infection conveyed by an insect which has previously been on carrion; the high fever and fatal blood infection are mostly results of the local disease.

---

[1] T. Billroth.

The ordinary carbuncle of the back is easily recognized by its broad inflamed base with perforations of the skin; on the lip, face, or head, it may be mistaken for erysipelas, but is readily distinguished by its hardness, purplish color, severe pain, high fever. The most successful treatment is as follows: Give an anæsthetic, cleanse the surface, and make a crucial incision through the entire mass; with a curette remove all of the dead and decomposing tissue, and break down and remove all portions which are apparently about to become disorganized. Use bichloride irrigation throughout the operation. When the wound is cleansed dust the surface with iodoform, pack its recesses with iodoform gauze strips, and cover the wound and the surfaces adjacent with gauze dressings. This dressing should not be changed for one week unless there is evidence that the disease has not been altogether arrested. In that case remove the dressing and destroy, as before, any remaining nidus of disease. Ordinarily the disease is at once arrested. The general treatment should be actively supporting: wine or whiskey as stimulants; quinine and iron; opium both to relieve pain and promote capillary circulation,[1] and easily digested nutritious food.

Phlegmonous inflammation, cellulitis,[2] may occur in any part of the body, but is most frequent in the hand, forearm, knee, foot, and leg; the cause is often obscure, but it may arise from injuries, infection, cold; the spontaneous form is more frequent in the extremities, above than below the fasciæ, and is especially prone to affect the fingers and hand, about the nails, panaritium. The disease is a serous exudation from the vessels, and infiltration of the connective tissues with quantities of young, round cells; it begins with pain, swelling, and redness of the skin, and usually with high fever; the tissues become tense, there is stagnation in the vessels at various points, especially in the capillaries and veins, and in some parts the circulation ceases entirely, resulting in extensive gangrene of tissues; as the inflammation spreads the entire inflamed part is changed to fluid matters, consisting of cells, with some serous fluid mixed with shreds of dead tissue; the process, finally, involves the skin, perforates it at some point, and the pus and débris escape externally. The inflammation now ceases to extend, the walls of the cavity unite, and the plastic infiltration of the part is finally absorbed, and the tissues return to their normal state. Or, the case may terminate fatally, owing to the absorption of the putrid products of suppuration, as in deep collections about the neck of old people. The treatment aims to arrest the development of the disease by securing the destruction of the infective materials of the diseased tissues. Incisions should be made into the cellular tissue and all dead matters and fungous granulations should be disinfected, or scraped out, and the entire internal surfaces cleansed with bichloride or carbolic solutions, and iodoform naphthaline, or boracic-acid dressings applied.

If the pus lie deeply in vascular parts, as the neck, the opening should be made, not by plunging a bistoury into the swelling, but by careful dissection, or after the skin and fascia are incised, by working a blunt instrument, as a director, cautiously through the structures, and, when pus appears, introduce the blades of forceps and expand them.[1]

---

[1] F. C. Skey.

[2] T. Billroth.

An ulcer[2] is a wounded surface which shows no tendency to heal; it starts mostly from chronic inflammation, and is always preceded by cellular infiltration of tissue; two opposite processes are combined, namely, new formation and destruction, the latter resulting from liquefaction of tissues through suppuration or molecular disintegration or both; two classes of ulcers result from this antagonism: (1) those in which the new formation predominates, proliferating ulcers; and (2) those in which suppuration and disintegration are most prominent, atonic or torpid ulcers. For the purposes of description the following forms are recognized: (1) The erethitic or irritable ulcer, which constantly has red and sensitive borders, bleeds readily, and the granulations are painful to the touch; the proper treatment is the destruction of this surface with nitrate of silver or the hot iron, and the subsequent compression with adhesive plaster; the hot iron is but slightly painful; if this treatment is not practicable, zinc ointment or lead lotions may be used, or other mild salves; (2) fungous ulcers exist when the granulations project above the level of the skin and are proliferating; the treatment requires that the surface of the granulations shall be destroyed by caustics, as the solid nitrate of silver or the hot iron; milder remedies are, compression with adhesive strips, or the elastic bandage,[3] and astringents, as oak bark, alum, Peruvian bark; (3) callous ulcers have thickened and hardened margins, owing to the long duration of chronic inflammation; the ulcer is torpid, lies deeply below the surface, with sharply rounded edges, and the surface is glazed. In treating the more tractable cases the indications to be met are, to soften the hardened borders and base, and to induce a proper amount of vascularity in these parts; the former is most thoroughly effected by the hot iron, or by strapping with adhesive plaster cut into long strips and applied partially around the limb and very firmly over the ulcers, drawing its edges down and towards each other; the second is best accomplished by moist warmth, as poultices or the continued warm bath.

To obtain healing of a callous ulcer of the leg, especially when it is situated on the anterior face and extends to the periosteum of the tibia, or when it surrounds the leg like a ring, it is often necessary to prepare the surface for skin grafting, and perform this operation.

Lupus[4] commences with small nodules in the superficial layers of the skin, more often on the face, especially on the nose, cheeks, and lips. They may enlarge and run together so as to form large nodules and tuberculous thickenings of the skin, L. hypertrophicus; or there may be a free exfoliation of epidermis on their surface, L. exfoliatus; or the surface may ulcerate, L. exulcerans; with strongly proliferating granulations, L. fungosus; or with rapid destruction of tissues, L. exedens.

The process commences essentially in the connective elements of the cutis, with very abundant new formation of vessels; the cutis at first becomes converted into separate, entirely circumscribed nests; then more diffusely into a layer of small cells which does not differ essentially from a common granular tissue; the cells have the form and size of the white elements of the blood, and often form under the mucous layer as sharply defined, large, round, or oval masses. The disease must be classified with new growths, consisting of granular tissue, characterized by such a copious aggregation of small exuberant cells that the elements of the cutis, and not infrequently of the still deeper seated layers of cellular tissue, are completely displaced and destroyed by them; this infiltration soon results in complete substitution, and if the exuberant cells disappear, there is permanent loss of substance which may appear as a special defect, or a contraction of parts, or sometimes as a scar; the disfigurements of lupus may, therefore, occur without as well as with open ulcers, for as the infiltrated parts recover they shrink to less than their former volume, as does ordinary cicatricial tissue, the skin appearing to be interwoven, with irregular, cicatricial lines, which may even acquire an irregularly filled surface.

---

[1] J. Hilton. [2] T. Billroth. [3] H. A. Martin. [4] R. Volkmann.

The treatment is exclusively local, and aims to remove every nodule: (1) by destroying affected tissues, and (2) by effecting in parts still firm and comparatively healthy the absorption of the lupoid cellular infiltration. The most effective method is as follows: For the removal of parts entirely converted into lupoid tissue, use sharp scoops; give an anæsthetic, and with the scoop scrape off or out all soft structures until the part is entirely free from the diseased structures; the necessary force may be employed for the scoop that will only remove diseased tissues; touch the surface lightly with the solid nitrate of silver, and cover it with small pieces of lint which should be allowed to dry, or cold applications may be made. For the removal of diffuse lupoid infiltrations with preservation of the layers of the skin resort to multiple punctiform scarification, as follows: The patient being under an anæsthetic, with a narrow-bladed, sharp-pointed knife, make hundreds or even thousands of punctures two or more lines in depth, close to each other; in many cases the skin after the completion of the puncturing appears of a lead color, or even suspiciously white, and resembles chapped flesh; but gangrene never has ensued; cover the part with lint, press it on firmly to stop bleeding, and leave it until it falls spontaneously; repeat the operation three, five, or even eight times if necessary, at intervals of two to four weeks; the skin gradually becomes firmer and loses its abnormal swelling and redness, while no cicatrices are formed. If this treatment is rejected, caustics must be used; of these, the caustic potash, or nitrate of silver in the stick, may be selected.

The attached crusts must first be removed by applying cod-liver oil one or two days; then bore the caustic stick into the soft lupoid granulations, retaining the potash in contact with the tissue much less time than the silver; wipe off the syrupy, tar-like mass with pads of wadding until a sound, firm surface appears; now cease to apply the caustics, for if the application is continued the erosions will be too deep, and disfiguring scars will result; apply simple dressings.

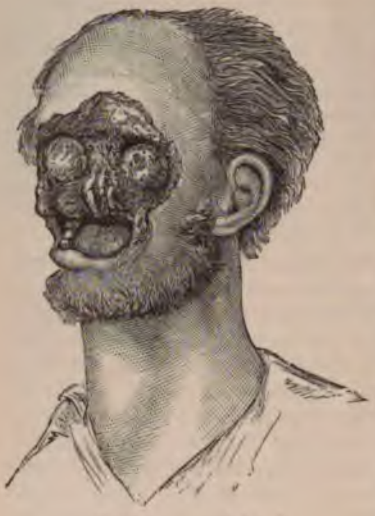
Rodent ulcer, or cancer,[1] begins as a tubercle or pimple, of a brownish color, and in elderly persons; at first a small scab forms upon it which is repeatedly removed, but finally ulceration occurs and slowly spreads. Its structure is essentially epithelial, and it is closely allied to, or is a form of, epithelial cancer.[2] The epithelial cells infiltrate the surrounding structures and undergo destructive disintegration; the progress of the ulcer is slow as it spreads by continuity of tissue, and not by glandular infection. The ulcer is depressed, of a pale pink color, with a furrowed rather than a granulating surface, slightly cicatrizing at one point while it spreads at another (Fig. 361), but eventually destroying all adjacent tissues until it reaches a fatal termination. It should be early recognized, as by complete removal its cure may be permanently effected. Whenever the ulcer is so situated that the entire disease may be removed with the knife, this method should be preferred, and the chasm should be covered with new skin by a plastic operation. Or, it may be possible to excise a portion and destroy the remainder with caustics,[1] the caustic being the chloride of zinc with flour, 1 to 3, mixed to a paste with water, and spread over the surface for two or three hours. When removed a slough forms which requires simple water dressings until it separates. If neither the knife nor caustics can be used owing to the location, the dressings should be iodoform. In some instances of neglect amputation is preferable (Fig. 362).

---

[1] C. H. Moore.

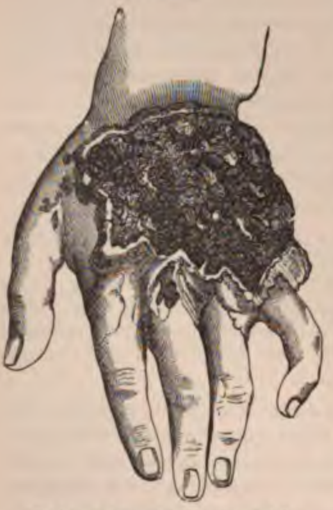
[2] J. C. Warren.

Fig. 361.



Rodent cancer of face.[2]

Fig. 362.



Rodent ulcer of back of hand.[6]

Elephantiasis arabum is an hypertrophy of the corium and subcutaneous connective tissue, beginning with an inflammatory stage, during which the lymphatic glands become swollen, and the lymph-paths through them permanently blocked, and resulting in stasis of the lymph, and hypertrophy. The treatment is rest, with the use of the elastic bandage for a long period; or ligature of the main artery to the limb;[3] the chief nerve of the limb has been divided with good results.[4]

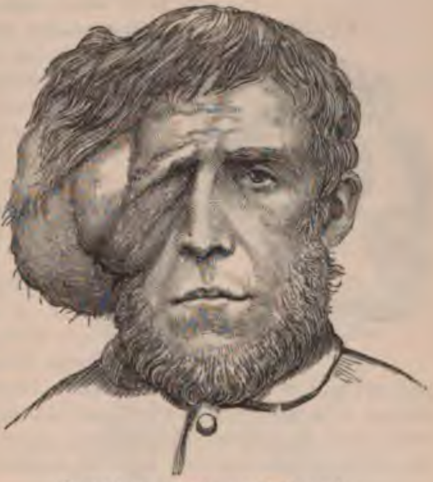
Soft fibrous or connective tissue tumors[5] are composed of a very tough, somewhat œdematous, white tissue, and are usually covered with the thin papillary layer of the cutis; on the surface there are almost always pointed papillæ. Even when the tumor is developed in a part of the skin which normally has no papillæ they usually hang loosely and are often distinctly pedunculated; the growth is slow, free from pain, and may develop into enormous tumors, and may be multiple; they occur towards the end of middle life, and are often found in women on the labia majora. The treatment is extirpation.

---

[1] C. H. Moore.
[2] T. Bryant.
[3] J. M. Carnochan.
[4] T. G. Morton.
[5] T. Billroth.
[6] J. E. Erichsen.

Pachydermatocele,[1] **molluscum fibrorum**[2] (Fig. 363), forms in the scalp, and often grows to a very large size. It consists of bundles of loose connective tissue and is abundantly supplied with vessels. The treatment is removal with the knife. Every precaution should be taken against hemorrhage, which necessarily complicates the operation.

Fig. 363.



Pachydermatous tumor of the scalp.

Sarcomata[3] of the skin are generally spindle-celled, and may be alveolar or melanotic; they usually ulcerate early, without, however, extensive destruction; they develop with peculiar frequency after precedent local irritations, especially after injuries; cicatrices are not unfrequently the seat of these tumors; black sarcomata may come from irritated moles. The diagnosis is often difficult, owing to the variable characters which they assume; they are generally of slow growth, free from pain, occur in middle life, and their location is at irritated points. The treatment is extirpation.

Epithelioma, squamous, of the skin, begins as a flattened and indurated elevation of the surface, and extends progressively both in depth and superficial area; when it reaches a certain maximum of development at its place of origin it breaks open at this point; the somewhat tuberculated surface grows rough, erosions, fissures, and holes appear in great numbers, and exude a white, inodorous, pulpy fluid mixed with pus; it next falls at its centre, and a hollow is produced which is henceforth marked, either by the dried secretions, or, when these are removed, by the sloughy shreds of the original tissue; it now has a hard base, and hard, raised edges; at the periphery the infiltration advances into the neighboring parts, while in its centre there is disintegration, and the phenomena of repair.[3] The most frequent seat is the face, especially the cheeks, brow, nose, and eyelids; the genitals, as the penis, the clitoris, the neck of the uterus.

---

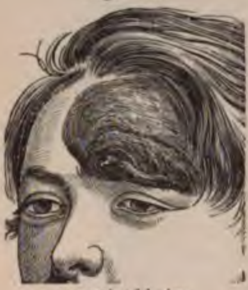
[1] V. Mott. [2] R. Virchow. [3] T. Billroth.

The treatment is extirpation by free incision, for this variety does not belong to the most malignant group of morbid growths; within a year the cicatrix usually becomes the seat of a new analogous growth, but cases occasionally occur in which the disease has not returned after radical extirpation.

III. THE HAIR AND GLANDS.

Overgrowth of hair can only be said to exist in hairy moles; these brown, hemispherical or flattened elevations seem to offer peculiar facilities for the most luxuriant growth of hair; not only are the individual hairs very stout, but they are shed and renewed much oftener than those of the head and beard. A vertical section shows at least one-fourth of the hair-follicles very thickly set and furnished with a little accessory sac occupied by a new hair in a more or less advanced stage of development. When the growth is a serious deformity, excision may be practised, or it may be removed by caustics,[1] as follows: The surface being shaved, apply the disk-shaped cautery at a red heat on the surface until a dark brownish eschar is produced; then immediately apply compresses wet in ice-water, and renew them frequently; by this means the patient suffers but little pain upon coming out of the anæthesia, the eschar separates in due time, and the granulation growth is kept level with the neighboring skin by the application of nitrate of silver. Or, the solid caustic potassa may be rubbed into the surface till the skin becomes a disorganized pulpy paste, its action being checked by diluted vinegar.

Fig. 364.



Growth of hairs.

Retention of secretions of the hair-follicles and sebaceous glands gives rise to a variety of affections commonly known as wens. The cause of retention is often a closure of the hair-follicle by over-secretion of epidermis and tumefaction of the sub-epidermic connective tissue about the mouth of the hair-sac. The retained secretion may often be squeezed out when it assumes the form of a worm, comedones; in other cases it has the appearance of honey, creating another variety, meliceris. The treatment, when they become large and troublesome, is extirpation; the dissection need not be carefully made, as it is not necessary to preserve the sac entire; when the capsule is reached it may be bisected and each half removed separately by evulsion; seize the edge with strong forceps and forcibly detach each portion.

Acne rosacea[2] consists of retention of secreted matter on the one hand and a peri-follicular inflammation on the other; the sac of connective tissue appears to be converted into pus, while hyperæmia, plastic infiltration, and suppuration follow one another in an area extending from half a line to two lines from the follicle. The

---

[1] G. Buck.

[2] C. Wagner.

Fig. 365.

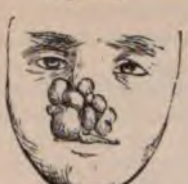
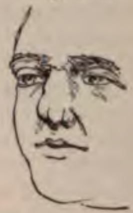


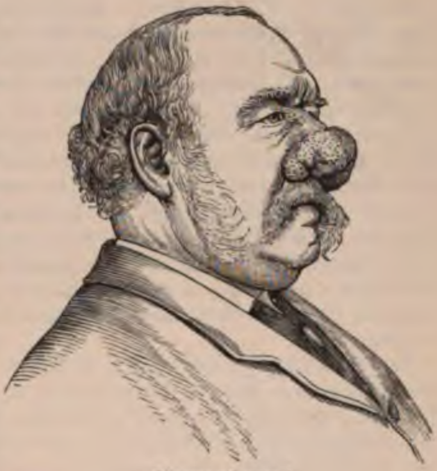
Fig. 366.



Distension of sebaceous glands.

growths have assumed such size (Fig. 364) by hypertrophy of the connective tissue as to require excision.[1] In the operation for the removal of the tumors, divide the pedunculated ones close to the cartilage; from the sessile growths remove slices by elliptical incisions, and dissect out from under the skin the hypertrophied tissue, care being taken to leave sufficient flap to cover the cartilage; close the wounds with fine silk suture (Fig. 366).

Fig. 367.



Lipoma of nose.[2]

Lipoma nasi[2] is a chronic hypertrophy of the cutaneous and subcutaneous structures, forming a large reddish-blue, vascular looking, soft, tremulous, and lobulated mass, enveloping the end of the nose, and producing excessive deformity (Fig. 367); there are all degrees of this disease, from mere clubbing of the organ to the formation of a set of pendulous lobular tumors attached to it. The sebaceous glands are greatly enlarged, often reaching the size of small peas. The deformity may be overcome by removal as follows:[3] Make an incision along the mesial line to the alar cartilages; dissect off these on each side, avoiding encroaching upon the nostrils by directing an assistant to keep his finger in it during the dissection, the surface is left to granulate.

IV. THE NAIL.

The nail consists of the flattened cells of the papillæ of the posterior part of the matrix, and of the mucous layer of the beds of the matrix; the former are pushed forwards along the beds in ridges, and the latter are added to the under surface of the nail.[4]

Inflammation, acute, may follow injuries, as blows, the penetration of sharp bodies; the chronic, is caused by syphilis, eczema, psoriasis; the result may be irregular growth of the nail, or its destruction by suppuration and ulceration; in unhealthy children the

[1] C. Wagner. [2] J. E. Erichsen. [3] M. Beck. [4] Virchow.

inflammation may be followed by the ulceration of the matrix. The treatment should be to relieve the inflammation by the removal of the cause, and such general and local remedies as the special conditions demand.

Atrophy and hypertrophy[1] depend upon the same conditions, namely, general diseases, as syphilis; local skin affections, as eczema, psoriasis; injuries, as pressure, blows, penetration of splinters, needles; trades, as hatters, gilders; fungi, as favus. In atrophy the function of the matrix is diminished, and the nail may become thin, small, narrow, soft, or be wholly lost. In hypertrophy, the functions of the matrix are increased, and as a consequence the nail may be of unusual length and width, appearing as if too small for its place; or the substance of the nail may be thickened throughout, but most considerably in front, having the shape of a chisel, with its thick base forward; or the thickening may chiefly affect the middle portion, so that it is elevated in the form of a cone or wedge raised in a shapeless hump, often continued in a long, straight, or curved, tap-shaped excrescence. The treatment of these affections is the same so far as they depend upon the same conditions. All sources of local irritation should first be removed; syphilis requires the ordinary general treatment, and the local application of mercurial plaster wound round the ungual segment of the finger or toe, so that it compresses the fold of the nail. Non-syphilitic affections require the same treatment as in other parts, but special effort must be made to secure the effect of the remedies upon the matrix and bed of the nail. In hypertrophy, India-rubber worn upon the part soon macerates the epidermis and diminishes hyperæmia of the papillary layer.[2] The local treatment should aim to remove such excrescences as are deformities and annoyances, by means of scissors, the knife, bone-nippers, or a fine saw, care being taken not to extract the nail from its bed.

Ingrowing is a curving downward of the margin of the nail, and in general is found on the external border of the nail of the great toe; it is due to the pressure of tight boots or shoes, and especially when the nail is hypertrophied; the fold of the nail becomes inflamed, the skin ulcerates, red, spongy granulations appear, and the part becomes exquisitely tender; the ulcerative process may extend backward, and finally the matrix and the whole end of the toe may be involved in the inflammation. The treatment at first should consist in attempts to heal the ulcerated point where the nail penetrates the skin. Of the various methods proposed select the following:—

Cut dossils of charpie, having parallel threads, of the length of the lateral fold of the nail, or rather larger; lay it on the nail parallel with the fold; by means of a flat probe push the mass down, thread by thread, between the swollen inflamed fold and the border of the nail, so as to completely separate the skin and the nail; pad around the furrow of the nail with charpie; apply long strips of adhesive plaster one and a half lines wide around the toe, from above downwards as regards the inflamed fold; repeat the dressing daily if necessary [3]

[1] T. Annandale. [2] Hebra. [3] Kaposi.

When the inflammation involves the whole fold and extremity of the toe, extirpate the portion of the nail involved, as follows: With sharp-pointed scissors slit up the nail (Fig. 368), then seize the offending portion, and with a slight twist remove it from the matrix (Fig. 369). When the inflammation extends completely around the nail, the entire nail should be removed and the matrix excised. Drop a four per cent. solution of cocaine hydrochlorate upon the raw surface in the furrows on each side of the nail; apply a cloth soaked with the solution against the upper surface of the toe, and inject the fluid in two or three places into the matrix; after an interval of fifteen minutes the nail may be removed without pain.[1] Or, apply a twenty per cent. solution of cocaine to the ulcerated point to relieve pain, now press a mass of lint into the space between the nail and the fold of skin covering it, and retain it by adhesive strip; repeat the dressing until the ulcer is healed.

Fig. 368.

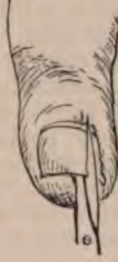
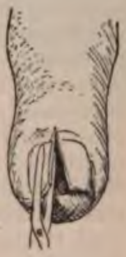


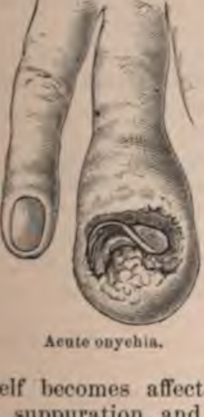
Fig. 369.



Removal of the nail.

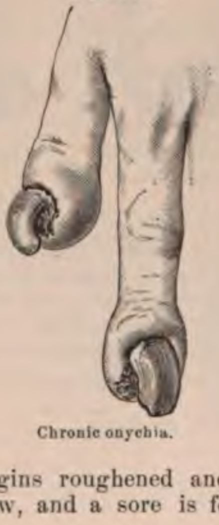
Onychia[2] is an inflammation of the matrix of the nail, causing ulceration, and gradually involving the soft textures around; it is sometimes the effect of injury, but more frequently occurs as a result of some unhealthy state of the constitution; the simpler forms begin with the usual signs of inflammation in the soft textures around the nail, which become red, painful, and swollen; the nail itself becomes affected, and its margins roughened and displaced; suppuration and ulceration follow, and a sore is formed

Fig. 370.



Acute onychia.

Fig. 371.



Chronic onychia.

---

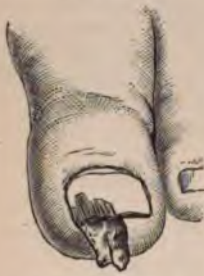
[1] F. P. Porcher.

[2] T. Annandale.

which is often kept in a state of irritation by the uneven margin of the nail pressing against it; the nail is loosened, its edges and root roughened and raised up. The most severe or acute form, onychia maligna, occurs in children, generally after slight injuries; the whole soft textures around the nail and at the extremity of the fingers become red and swollen, giving it a hollow appearance (Fig. 370); the discharge is thin and fetid, the nail is loosened, and the bone may be expanded. In the mild or chronic form (Fig. 371) use nitrate of silver to arrest the ulceration, and remove the nail if it keeps up the irritation. In the severe forms, remove the nail at once, and freely cauterize with caustic potassa, nitric acid, or nitrate of silver. The nail is best removed as follows: The patient being under an anæsthetic, thrust the sharp point of strong scissors under the nail and through the matrix (Fig. 368); now seize one section of the nail with strong forceps (Fig. 369), and by sudden eversion tear it from its position.

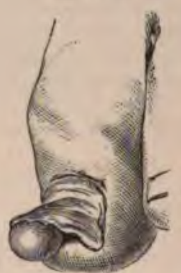
The claw-like nail, onychogryphosis, depends upon a hyperplastic state of the entire matrix of the nail (Fig. 371); the long, horizontal papillæ furnish nearly all the substance of the nail, which is no thicker at the finger-tip than at the ridge of the lunula; this gives the nail its ridged appearance, each ridge corresponding to a papilla.[1] The only reliable remedy is complete removal of the nail and its matrix,[2] with such general treatment as the case requires.

Fig. 372.



Horny growth from beneath the nail.

Fig. 373.



Ungual exostosis.

Horny growths (Fig. 372), resembling exostoses, sometimes appear at the margin of the great toe, and create much suffering. The only treatment is excision.[2]

Ungual exostosis (Fig. 373) is a bony growth from the last phalanx of the great toe, which can only be permanently cured by excision.

Psoriasis[3] appears as a thickened, rough, scabrous, and unusually convex condition of the central portion of the nail; the free edge is often split, and the cuticular fringe at the bottom of the nail is ragged and retracted; the whole nail resembles the concave shell of an oyster. If it is caused by syphilis, give mercury in small doses for a long period; if not specific, give arsenic with a tonic. The appearance of the nail is improved by smoothing with glass or sandpaper; or by friction, with dilute acetic acid.

---

[1] E. Rindfleish.

[2] T. Bryant.

[3] T. Smith.

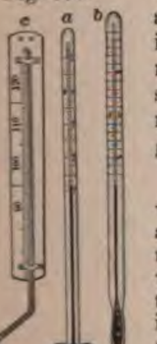
CHAPTER XXXIII.

GENERAL OPERATIONS ON THE TEGUMENTARY SYSTEM.

I. THE SKIN.

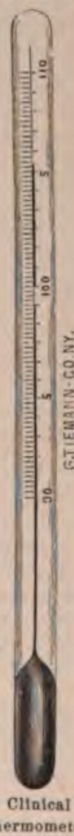
Thermometry[1] is generally practised upon the skin to determine with exactness the state and variations of bodily temperature. Two kinds of instruments are now employed, one, *b*, *c*, to be used in inclosed cavities, and the other, *a*, upon the surface of the integument. Many varieties of the former instrument are now in use, but the straight, self-registering, clinical thermometer (Fig. 375) is recommended for general use.

Fig. 374.



Thermometers.

Fig. 375.



Clinical thermometer.

An indispensable condition for accurate investigation is that the instrument itself be accurate; to determine this question, the thermometer should be tested by placing it in a water-bath with a standard thermometer and the variation noted; as the glass changes by use it is found that clinical thermometers change, and hence it is desirable to repeat the test occasionally. The same thermometer should be used continuously on the same patient.

The introduction of this instrument into the well-closed axilla appears to be the most convenient method in the great majority of cases; its use in this situation is attended by scarcely any difficulties, and no objection can be made on the score of decency.

The application of the instrument in the inside of the mouth apparently affords uncertain indications, because the cool air inspired may easily lower the temperature; but the mouth must be employed when other parts are inaccessible; taking the temperature in the rectum and vagina is repulsive, and can seldom be repeated often enough, and is to be resorted to only in infants, in the emaciated, during collapse, and other special circumstances.

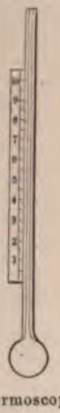
Use it as follows: If the axilla is wet with perspiration wipe it dry; press the arm against the side to close the cavity for a few minutes, all clothing being removed from it; warm the whole instrument in the hand to 85° F. or 90° F.; now place the bulb deep in the axilla behind the anterior fold, the stem inclining upwards, and close the axilla by pressing the arm firmly against the chest; the arm should be firmly held in position, the stem being lightly covered with the clothing. The instrument should be accurately retained in the closed axilla at least five minutes; on removing it note the point of elevation or depression of the upper end of the column. The circumstances of the case and the objects sought to be attained must decide the question of time and frequency of the observations; it is desirable to repeat the observation at a similar time each day; usually it is sufficient to make the observation twice daily, which is best done between seven and nine A. M., the period of probable lowest daily temperature, and in the evening, between four and six o'clock, the period of probable highest daily temperature. The surface thermometer must have its broad extremity placed upon the part to be examined, and be held in position about five minutes.

---

[1] C. A. Wunderlich.

The variations of temperature and rate of any part of the surface may be accurately determined by the thermoscope (Fig. 376).[1] It consists of a glass tube seven inches long with a minute bore, open at one end, and terminating at the other in a bulb; an adjustable scale is attached to the outside of the tube. Prepare it for use as follows: Immerse the bulb in hot water to rarefy the air inside; then plunge the open end into cold water and quickly withdraw it, when a drop or two will be found to have entered the tube, and will form a water index which should become stationary within an inch or two of the bulb; adjust the scale, bringing its lowest figure on a level with the top of the column of water in the tube. It may be applied to any surface, and registers the volume of heat escaping by radiation and the velocity of loss.

Fig. 376.



Thermoscope.

Rubefacients produce intense irritation, redness, and congestion; their effect is temporary, and in proportion to the extent of surface covered; they are preferable to blisters to arouse the system.[2]

Mustard is used in the leaf with vinegar, as essential oil, as a flour sprinkled on a wet cloth, or laid on paper sinapisms, or as common paste, made by adding water of the temperature of 90° to 160° F. Linseed or Indian meal may be added to diminish its action; one part of mustard to sixteen of meal will make a slightly irritating poultice, which children with acute diseases of the lungs will wear continuously with great benefit; remove the mustard before the skin is broken, wipe the surface with a wet cloth, and dress the part with cotton-wool or well-oiled cloth. Make the application directly to the skin when prompt action is required, but interpose a thin cloth when more permanent effects are sought. An artificial essential oil of mustard may be used, namely, sulphocyanide of allyl in solution in alcohol, one to fifty. Capsicum may be used in a poultice, or on cloths wet with a strong watery solution. Turpentine is a highly stimulating application, and may be used as a liniment, or sprinkled on a wet cloth; it reddens the skin very promptly, and the surface requires no other attention. Dry-cupping draws the blood to the skin, where it remains many hours, relieving deep-seated congestion; apply the cup with an exhaust pump, or use the common cupping-glass, or a small tumbler, or other accessible cup; moisten the internal surface with pure alcohol; ignite with a burning wisp of paper, and invert the cup on the part. Croton oil causes a fine pustular eruption, and is applied by rubbing briskly one part of oil to three parts of olive oil, and repeating carefully, limiting it to the part. Potassio-tartrate ot antimony, tartar emetic, causes a large pustular eruption, and is applied as an ointment, well rubbed into the skin; the surfaces are to be dressed as after the application of mustard. The strong tincture of iodine repeated several times, and nitrate of silver, in concentrated solution, or mixed with lard, produce desquamation.

---

[1] E. C. Séguin.

[2] H. C. Wood.

Vesicants are more permanent in their effects than rubefacients; their local action consists in first diminishing and then destroying the vitality of parts with which they are brought in contact; this local action is depletory, as by increasing the amount of blood in the tissues immediately under the blistered surface, the deeper subjacent structures are rendered very anæmic; they also affect the heart through the nervous system, the weak strengthening, and the powerful depressing its action.[1]

There are many agents which may be made to act as vesicants, as cantharides, ammonia, hot fluids. Cantharides acts most promptly on the young, and on parts where the integument is thin. It may be used in the form of blistering liquid, cantharidal collodion, applied with a brush, or of tissue, or of the officinal emplast. cantharis. The surface to which it is to be applied should be cleansed, and if there is liability to stranguary, dusted with camphor, or covered with oiled tissue paper. Fresh cantharides will vesicate within three to five hours; if not fresh, vinegar applied to the skin or plaster will often hasten its action. The redness of the surface and small blisters are evidence of the action of the vesicant; the application of cloths wrung out of hot water, or a poultice, causes immediate effusion of serum; open the blister with a needle at the most depending part; allow the cuticle to fall upon the surface underneath; dress the surface with oil or simple cerate. To make the effects of the blister more permanent, remove the cuticle and apply stimulating substances, as the leaf of the cabbage, beet, ivy, or savin ointment. To vesicate quickly, apply chloroform on cotton covered by a watch-glass or saucer; or liquid ammonia on a swab, or hot water. A heated iron, thermal hammer, dipped in water of 120° F. and applied to the skin two or three seconds, is a rubefacient, and continued five to ten seconds is a vesicant. If excessive inflammation, or erysipelas, follow the blister, apply poultices of bread and water or flaxseed.

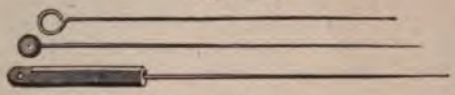
The endermic application[2] of remedies is frequently preferable to administration by the stomach or hypodermically. The method consists in introducing the substance into the skin by rubbing, inunction, or occasionally it will be useful to remove or to irritate the cuticle, and to apply the remedy to the denuded or reddened spot. Morphine and quinine may be thus applied; but they must be used in quantities about one-third larger than when applied hypodermically.

Mercurials are generally applied to the unbroken skin, for instance, the ung. hydr., or ung. hydr. nitrat., or the oleate of mercury. Solutions of alkaloids in oleic acid, such as the oleates of morphia, aconitia, veratria, atropia, and quinia, are very readily absorbed. The quantities usually employed for a single application are the following: morphia, one-sixth to one-half grain; veratria, one-twelfth to one-third grain; strychnia, one-twentieth to one-twelfth grain; atropia and hyoscyamia, one-sixtieth to one-twentieth grain.[3]

[1] A. W. Hollis. [2] W. Bernatzik. [3] C. Rice.

Acupuncture is a method of counter-irritation effected by passing slender needles into the part, and allowing them to remain from a few minutes to several hours. The needle should be of steel, from two to four inches in length, polished, very sharp-pointed, flexible, and soft, having a metallic head (Fig. 377).

Fig. 377.

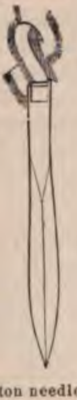


Acupuncture needles.

They are inserted by making the skin tense with the left hand, and with the right introducing the needle, with a rotary motion, to the required depth, avoiding joints and viscera. They may safely penetrate several inches, and have even been introduced into viscera without ill effects. They are liable to become oxidized, and on removing them pressure should be made upon the adjoining surface, while the needle is rotated slightly.

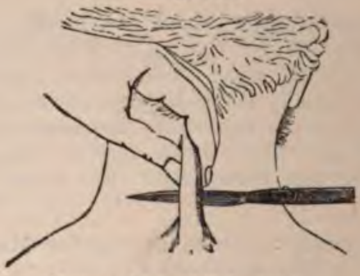
The issue is a suppurating wound of the deeper structures of the skin. It may be made with a seton, incision, caustic, or moxa, and must be so limited as not to extend its action beyond the subcutaneous areolar tissue. Apply them at points as free as possible from sources of local irritation, and remote from large vessels and nerves, as the nape of the neck, the insertion of the deltoid on the arm, the external part of the thigh and internal part of the leg. The seton may consist of a few threads, a piece of linen, or of lamp-wicking, or what is now more frequently used on account of cleanliness, a strip of India-rubber cloth. The instruments required for its introduction are either the seton needle (Fig. 378) or a straight bistoury, and a probe having an eye. Pinch up a fold of the skin corresponding with the direction of the muscles of the part, or vertical with the body, pass the needle, armed with the seton, deeply through the parts, but without involving tendons or muscles; draw the seton through and tie loosely. If the bistoury and eyed-probe are used, pinch up the integuments and transfix with the bistoury (Fig. 379); pass the probe having the seton through the eye, or attached by a thread (Fig. 380), through the wound, and tie. The subsequent dressings consist of greased lint, and a bandage around the part to be exchanged for a

Fig. 378.



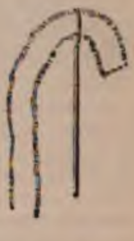
Seton needle.

Fig. 379.



Puncture for seton in the neck.

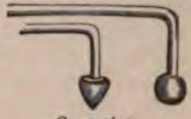
Fig. 380.



Seton on a probe.

poultice when suppuration commences. The seton must be drawn through daily, and the part saturated with pus cut off. When an issue is made with the knife, the incision must penetrate into the subcutaneous cellular tissue, and a foreign body, as a pea, or a small bead, is introduced and retained by adhesive straps until suppuration is established. The caustic may be the actual cautery, or Vienna paste, or other powerful escharotics. In shape, the iron cautery should have a more or less flattened surface, when it is required to produce a superficial slough, or conical when it is required to penetrate more deeply (Fig. 381). If it is applied at a white heat, and firmly pressed upon the part until an eschar is formed, although not severely painful, local anæsthetics should be used; cold-water dressings should be applied for several hours, followed by moist warm applications, as a poultice, until the slough separates.

Fig. 381.



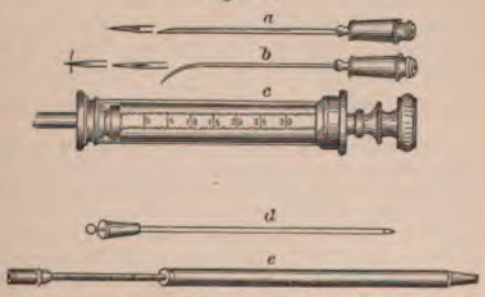
Cauteries.

Vienna paste is prepared by triturating equal parts of quicklime and caustic potassa; it is applied to the part, of the required size, and allowed to remain ten or fifteen minutes; when removed, wash the surface with diluted vinegar, to counteract its action. Caustic potassa may be used in a similar manner, the parts being circumscribed by a piece of adhesive plaster, through an opening in which the application is made. Strong sulphuric acid also makes an issue of the proper depth, its effect being controlled by an alkali.

The subsequent dressings are poultices. The moxa is a combustible substance, burned upon the surface; it may be composed of lint, carded cotton, hemp, agaric, etc., or the lint may be saturated with the nitrate of potassa. The substance selected should be firmly rolled into a pyramidal form, and held together by threads, or a solution of gum arabic; should be an inch and a half long, and of a diameter at the base corresponding with the size of the proposed eschar. Local anæsthesia being produced, the moxa is held in position with forceps or wire, and is ignited at the top; as it burns down, any desired degree of irritation can be obtained, from a simple redness to a deep eschar, according to the time it is maintained in contact with the skin.

Hypodermic injection is a method of inserting remedies into the subcutaneous areolar tissue. Its advantages are, rapidity of action; intensity of effects; economy of material; certainty of action; facility of introduction in certain cases; with some drugs the avoidance of unpleasant symptoms.[1] The apparatus required is a hypodermic syringe, needles, and solutions.

Fig. 382.



Hypodermic syringe and needles.

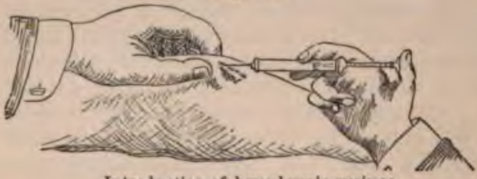
---

[1] Com. on Hypodermic Method.

The syringe consists of a barrel and rod, and a canula of silver or steel, which has a point for penetration and an opening for injection of the liquid (Fig. 382); *a*, *b*, *c*, is a form with a glass tube, a graduated rod, and detachable points of two shapes; *d*, *e*, is a form of hypodermic syringe to be carried in a pocket-case; the point, inclosing the wire-cleaner, fits into a hollow graduated piston; the barrel is an ordinary silver tube, the size of No. 10 catheter, and is six inches long.

There are numerous cases, varying in size to suit the convenience of practitioners. To meet the increasing necessities of this form of medication the case[1] should contain a double fenestrated hypodermic syringe; three needles of different sizes, the smallest being the most delicate manufactured, the second larger, and the third of the ordinary size; extra leather washers and wires for keeping the tube open and clean; a small hone of the finest quality for sharpening the points; a twenty-four minim glass measure perfectly exact; five two-drachm vials filled as follows: (1) sol. sulph. morphia, 16 grs. to the ounce, or $\frac{1}{2}$ gr. to 15 m.; (2) sol. sulph. morphia, 8 grs. to the ounce, for children, or delicate females; (3) sol. atropine, 1 gr. to the ounce; (4) strong alcohol for cleaning the points; (5) fluid ext. ergot. The case may contain other solutions, a thermometer, and thumb lancet. It is not necessary to confine the injection to the painful part, and thus a tendency to abscess from repeated injection may be avoided.[2] As a rule, the least pain and irritation are caused when the injection is made at or near the insertion of the deltoid, or in front, between the ribs and hip-bone, or from near the spine to the median line. Operate thus: On the first trial always use a minimum quantity of the drug;[3] draw the required amount into the syringe; elevate the point of the needle and force out a drop to expel the air; pinch up the skin at the point selected and thrust the needle into the subcutaneous connective tissue, avoiding any veins apparent (Fig. 383); now gently force the fluid out drop by drop, watching its effects; if no effect is produced when the last drop is injected, withdraw the needle instantly and press the finger on the puncture for a moment; if faintness or other usual symptoms appear, withdraw the needle and apply such restoratives as may be required.

Fig. 383.



Introduction of hypodermic syringe.

The needle[1] may be little larger than the proboscis of a fly, so delicate in fact that fluids as thin as water barely pass through it, and that quite slowly; it will penetrate the skin and reach the cellular tissue without pain, the little child and delicate female not being aware of its introduction in the cervical and lumbar-spinal regions, or about the insertion of the deltoid. The needle should not screw on, but slide in, and thus avoid the wearing of the screw and the destruction of the thread. To keep the leather washer of the piston always damp, draw a few drops of water into the barrel after using it, and let it remain; when about to use the syringe, draw this water out, and the piston will work well. Prepare the solution of morphia sulph. by putting four grains in the vial and filling it with hot water; no acid is required to make and keep this a perfect solution; it is generally required in an emergency, and should always be in the case; it keeps indefinitely. To clean points draw the alcohol up and force it out of the tube several times; then detach the point and blow through the tube; finally, pass the wire through, wiping it every time it is withdrawn, after which leave the wire in the point.

---

[1] W. A. Greene. [2] C. Hunter. [3] F. E. Anstie.

Vaccination destroys or diminishes susceptibility to variola; every practitioner is under imperative obligation to exercise reasonable care and diligence in the protection by this means of all persons subject to his professional advice and care.[1] It may safely be performed at any period of life, and no age should exempt a person from vaccination who has been exposed to smallpox; the most suitable period is six weeks from birth, and it should not be delayed beyond the third month, unless unfavorable conditions are unavoidably present, as acute febrile diseases or vesicular eruptions.[1]

The practitioner is responsible for the purity of the lymph which he uses, for pure virus can cause no other disease than variola; diseases are invaccinated only when the lymph is contaminated with blood, pus, or other carriers of contagia.[2]

Lymph is of two kinds, human or bovine, according as it is taken from man or animal. Humanized virus must be selected from children of healthy parentage, and free from all hereditary taint, and cutaneous or other discoverable affections. In the collection of lymph, the following rules should be observed:—[3]

The vesicles should be perfect, having passed through all the stages without complications. Lymph must be taken from the vesicle before the areola has formed, the most favorable period being the eighth day, or day week after vaccination. Several fine punctures should be made in the top of the vesicle, when the lymph will exude from the cells and may be taken for immediate use, or for preservation. The vesicle should never be squeezed to obtain more lymph, but the surface may be gently wiped with a wet cloth to remove any obstruction of the puncture. If any blood appear it must be allowed to coagulate, and then be removed, before lymph is again taken. The virus may be taken on points, pieces of ivory, or quill scraped smoothly, two coats being plied; or in capillary glass tubes into which the lymph is drawn by capillary attraction, and which are sealed at both ends by the flame of a candle, to the exclusion of the air. The lymph is frequently preserved in the scab, or crust, which is the dried vesicle. This falls between the twentieth and twenty-fifth days, is of a mahogany or amber color, and semi-transparent. If there is pus or blood in the scab, that portion, or the whole, should be rejected. The virus, in whatever form, must be preserved from the air, and kept in a cool place.

Vaccination may be successfully performed on any part of the body; but for convenience and freedom from irritation, the arm near the insertion of the deltoid muscle is ordinarily selected. The left arm is preferred to the right, in first vaccination, as it is not so much used. Though the operation is extremely simple, it requires great care and delicacy in its performance. A variety of instruments have been used, but a common lancet, slightly dull, answers every indication. It should be kept in a state of perfect cleanliness, as rust or filth is liable to poison the wound. After each vaccination it should be cleaned with a wet cloth. The operator should grasp the arm so as to make the skin tense at the point of insertion of the virus, and either make several punctures with the point of the lancet, thus ⁘, or several incisions, thus ||||, or abrasions, thus #. The lancet should penetrate sufficiently to cause the appearance of blood. If the virus is taken from another arm, the point of the lancet should be charged by uncapping cautiously one of the cells of the vesicle. If the quill is used, first wet the charged extremity with a drop of water. If the scab is used, dissolve a small portion in a drop of water or glycerine on a piece of glass, and charge the point of the lancet. Whatever form of virus is used, be careful to rub the lymph well into the abrasions; the flow of blood, though considerable, does not interfere with the success of the operation.

---

[1] E. C. Seaton.
[2] J. Simon.
[3] J. B. Taylor.

The following facts[1] in regard to the progress of successful vaccination, and the complications which may arise, are important: After the inoculation, a period of inaction, comprising three or four days, is followed by a papule-like elevation of the skin, due to swelling of the cells of the deep layers of the epidermis, accompanied by hyperæmia; these cells continue to enlarge, and, by the fifth or sixth day, the pock is found augmented in size, and, from increased distension of the cells, presents the appearance of a vesicle, with a central depression, and is multilocular in structure. The contained fluid (*vaccine lymph*) is a colorless, adhesive liquid, containing leucocytes and minute granules, in which latter resides its virulent property. The papillary layer of the derma is now invaded by the morbid process; the free ends of the papillæ become strangulated by cell-impaction, and, melting down, mingle with the fluid contents of the pock. Occasionally, the disease extends completely through the derma, and involves the subjacent cellular tissue, which then shares the fate of the destroyed papillæ. On the eighth day (inclusive) the pock has, if it have been produced by long-humanized virus, acquired its greatest size; if it have been produced by bovine virus, or by humanized virus of early removes, it continues to increase in size for several days longer. On the ninth day the pock has increased in plumpness, its central depression is more marked, a brown incrustation has begun at the centre, the fluid contents are more decidedly purulent, and the whole is surrounded by a sharply-defined, bright redness of the skin, extending over a disk of from one to two inches in radius, and technically called the *areola*. In the human subject the areola is usually accompanied by febrile reaction; but in the calf there is no areola, and but little, if any, constitutional reaction. The further progress of the disease consists in the gradual fading of the areola, with the transformation of the entire pock into a hard, dry, translucent brown crust, which separates some time between the fifteenth and the thirty-second days, leaving a more or less depressed cicatrix, which is usually permanent, and which shows numerous lesser depressions, which give it the appearance termed foveolation. If the individual have previously had the disease, it usually runs a more rapid and less regular course, although the inflammation is apt to be more marked. Vaccina usually runs its course without complications, and does not call for treatment. Excessive erythema is best treated by the application of a liniment composed of ℥ij of ung. stramonii, ʒj of liq. plumb. subacetat., and ℥viij of linseed oil. True erysipelas is very rarely caused by vaccination, and does not require a modified treatment. Axillary adenitis is common, and should be treated on general principles. The same is true of cellulitis. Ulceration of the pock (generally caused by violence) may be treated by sprinkling with equal parts of powdered starch and oxide of zinc, and the same may be used to check an immoderate flow of lymph, after opening the pock for the purpose of obtaining virus.

---

[1] F. R. Foster.

Transplantation of skin is frequently required to repair defects either congenital or due to injuries and diseases which cause destruction of integument. These operations are chiefly confined to the face and joints, and have for their special and ultimate object the relief of the disfigurements, and the restoration of function of the parts involved, as of the mouth, or nose, or eye. Innumerable special operations have been planned and executed to meet the ever-varying indications which these deformities present; but there are certain underlying principles which should always govern the procedure, whatever method may be adopted. The object[1] in all cases is to obtain union by first intention, and to effect this purpose, (1) the flap must be of such ample size that subsequent shrinking will not interfere with the perfection of the cure; (2) there must be no effusion of blood forming a clot under the flap; (3) the margins of the flap must be held accurately together with the smallest amount of irritation. The more important features of the operation are as follows:[2] (1) in the choice of skin, select that which is normal and in healthy condition; dispose the patch of skin to be transferred so that its long axis corresponds to the direction in which the arterial vessels are distributed, and the free extremity of the patch towards their destination; (2) to secure precision in adapting a patch of skin to a new locality to which it is to be transferred, first prepare the space to be filled by paring its edges and dissecting them up sufficiently from their underlying connections to allow of their eversion; cut from oiled silk an exact pattern of the space and apply it to the surface which is to supply the new material; insert small pins at intervals around the pattern, at a distance of one line from the margin, as an allowance for shrinkage, but a larger allowance must be made for the length, so as to permit the patch to be brought around edgewise without strain. The methods of transfer of the skin are as follows: (1) By approximation; when the skin is supple and movable on both sides of the space, pare the opposite edges, dissect up the adjacent skin to a sufficient distance to permit their meeting and being secured by sutures; if there is too much strain, make incisions through the skin parallel with the wound; (2) by sliding; if upon one side only the skin is sound, prepare the space, and dissect up a patch of the required size in the healthy skin; glide this patch edgewise over the space, and attach its edges by sutures; (3) by transfer to a distance; this is done either by transferring the patch edgewise, but making its pedicle describe a part or the whole of a semicircle, or by jumping over intervening tissue, and severing the pedicle when union has taken place. The operation should be antiseptic. The raw surface left after transfer of a patch may often be covered by the transplantation of a second patch; if not, the surface should be treated as an open wound with iodoform dressings. The suture used may be (1) the interrupted antiseptic thread; the needle should be trocar-pointed; the glove-makers' thread answers as well as wire; insert the needle obliquely from the edge backward so that the suture will have a tendency to evert the edges of the wound; insert sutures enough to secure exact coaptation, for multiplicity is not objectionable; (2) the common figure-of-eight; (3) the beaded wire clamp as an auxiliary for the support of other sutures.[1] Apply antiseptic dressings.

---

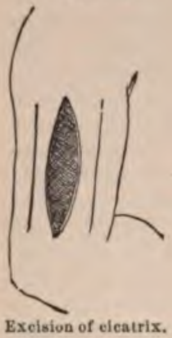
[1] T. Holmes.

[2] G. Buck.

The head of silver wire with a glass bead on the extremity, held in place by a disk of leather; the wire being drawn through the two sides at the desired point, another bead is slipped down and pressed firmly against the wound, while the wire is fastened by twisting the end round a piece of wood; this suture may remain for six to ten days, and if immediate union fail, they still retain the parts in good position for union by granulation.

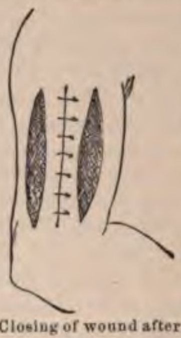
Cicatricial contractions[2] follow all wounds with extensive loss of skin, and as this is generally greatest after burns, cicatrices from this cause usually contract most; it results from the disposition of the inflammatory new formation in the wound to give off water, as the original gelatinous tissue by degrees atrophies to dry connective tissue. Operations should not be undertaken for the relief of cicatricial contractions until every proper effort has been made to overcome them; for in the course of months or years the vessels are obliterated, and the structure becomes more like that of subcutaneous tissue, being less rigid, more distensible, tougher, more elastic; hence mobility increases with time. This atrophy of the cicatrix may be aided by compression and distension, long and persistently applied. When these measures have accomplished all that can be reasonably expected, some one of the many methods practised may be adopted. In general, the entire cicatrix should, if possible, be removed, and its place supplied with new skin. This may be effected when the cicatrix is narrow and linear (Fig. 384), as follows:[3] Dissect out the cicatricial tissue cleanly; now make incisions on either side of the wound, parallel to its borders, and two, three, or more inches from them, through the subcutaneous tissue; loosen these strips sufficiently to permit of their accurate approximation; unite them by suture and allow the lateral spaces to heal by granulation (Fig. 385). In many cases the distorted parts may be liberated by detaching them from their underlying connections sufficiently to allow them to be restored to their normal relations, and then transplanting sound skin from the nearest available locality with which to fill up the space made bare by the restoration.[1] Finally, the corded folds that maintain the contraction may be excised and the

Fig. 384.



Excision of cicatrix.

Fig. 385.



Closing of wound after removal of cicatrix.

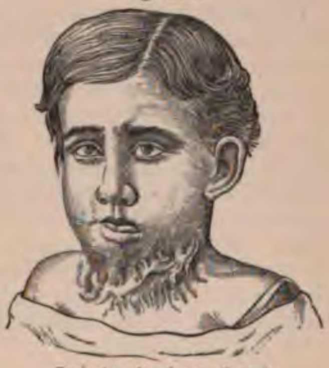
---

[1] G. Buck. [2] T. Billroth. [3] T. D. Mütter.

edges of the wound divided at every point where any resistance still remains which prevents complete extension of the part, or even dissecting up the edges from their underlying connections, the purpose being to give the utmost freedom of motion; the second step is by mechanical appliances to maintain parts in their restored position until cicatrization is complete, and for a longer period if necessary; the third factor in the cure is to regulate the process of cicatrization so as to keep a smooth and even surface, by repression of the granulations with caustics thoroughly applied, and by adhesive, or better, rubber plaster, applied firmly and so as to overlap each other; if contracting bands form, they must be divided; cicatrization may be aided by leaving islets of cicatricial skin on the wound or by transplanting skin to the part.[1]

The selection of any one method must depend upon the situation and condition of the particular cicatrix. In the flexure of joints, simple subcutaneous division of the bands at many points, combined with extension by instruments, will frequently prove successful; where the cicatrix is broad, flat, and dense, transplantation of skin must be practised; if the lip is destroyed, it may be reconstructed by a series of operations; if the lower eyelid is injured, the cicatrix may be replaced by the healthy skin of the cheek; if the lower jaw is depressed and fixed, the cicatrix may vary in extent and firmness so much as to require a judicious selection of one or more methods in any individual case. The following operation on a cicatrix of the neck illustrates a combination of methods: This cicatrix generally consists (Fig. 386) of a broad, dense structure, extending from the lower border of the under jaw to the top of the sternum and clavicles, and preventing the elevation of the jaw; the saliva escapes from the mouth, and the tongue is exposed to view. Operate as follows:[1] First, divide the entire cicatricial band into three serrated angular flaps, by two diverging incisions carried from the symphysis menti downward and outward to either lateral margin of the band where it joins the clavicles; from these terminal points make incisions, one along either margin of the band upwards and outwards to the lower edge of the jaw; dissect up these three flaps from the connective tissue, beginning at their apices, and proceeding toward and slightly beyond their bases; the head is thus relieved and can be moved in every direction; readjust the detached flaps to the denuded surface while the head is kept in an elevated position; excise redundant folds and pare off the edges of the flaps, if necessary, to adapt them to each other; incision may be made along the base of the neck to relieve tension; in the subsequent treatment the chin must be maintained elevated by apparatus, as a stock, or a chin-support attached to a spiral brace; if at any time the granulations become exuberant, they are reduced by applying the solid nitrate of silver and pressing it firmly into them, or by the caustic potassa; if new cicatricial bands form, they are divided at two or more points, and entirely through their thickness. The result is, in ordinary cases, complete relief from the effects of the cicatrix.

Fig. 386.



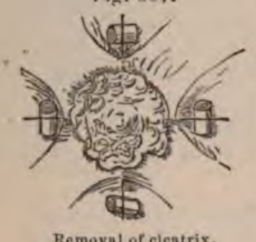
Cicatrix after burn of neck.

---

[1] G. Buck.

Great care is necessary in the division of these cicatricial webs, as the vessels and nerves underneath them may be included in the cicatrix.[1]

Fig. 387.



Removal of cicatrix.

The obliteration of depressed cicatrices after glandular abscesses and exfoliation of bone has been effected by the following operation:[2] Subcutaneously divide all of the deep adhesions of the cicatrix with the tenotomy knife introduced a little beyond its margin and carried down its base; carefully and thoroughly evert the depressed cicatrix, turning it inside out so that the cicatricial tissue remains permanently raised; pass two harelip pins, or finer needles, through the base, at right angles to each other (Fig. 387), so as to maintain the cicatrix in its everted and raised form for three days; remove the needles and allow the cicatricial tissue to fall to the level of the surrounding integument.

Cheloid tumors occasionally develop in cicatrices. The false cheloid are liable to develop in cicatrices which belong to the sarcomatous series. These tumors rather replace a scar, than grow out of one. In the regular course of development of a scar, the presence of round-cell and spindle-cell tissue is only provisional as they speedily give place to fibroid tissue. Either one of these elements may persist longer than its proper time, and if it accumulates in disproportionate amount, a sarcomatous tumor is produced instead of a scar. They appear as nodular hypertrophies of the cicatrix, of a dusky or bluish color. They may give rise to no symptoms, and finally disappear, or they may become very sensitive and painful, with intolerable itching. No treatment is required, unless the growth is very troublesome. The most efficient remedies are blisters; these may be followed by friction, with mercurial ointment and extract of belladonna. If no relief is obtained, excision of the cicatrix must be performed, to be repeated if the growth returns.

Warty tumors of cicatrices,[3] false keloid, are the result of an abnormal increase in the development of cicatricial tissue of a fibro-cellular character; the granulations are large and fungoid; the appearance is that of the scrofulous ulcer in children. The disease is more often seen in the cicatrix of burns, and occasionally proves to be epitheliomatous. When they form on cicatrices over bones they penetrate, and cause caries, as of the tibia. The treatment of the non-malignant form is by the hydrated zinc powder, lightly sprinkled over the surface at intervals of five or six days; a light slough forms, which separates, and leaves a more healthy surface. If the growth proves to be malignant, excision or amputation must be performed.

---

[1] T. Bryant. [2] W. Adams. [3] Sir C. Hawkins.

VII.

THE DIGESTIVE ORGANS.

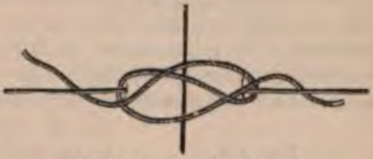
CHAPTER XXXIV.

THE LIPS.

I. WOUNDS OF THE LIPS.

THE lips are covered externally by skin, internally by mucous membrane, and contain fat, glands, and muscle.

Fig. 388.



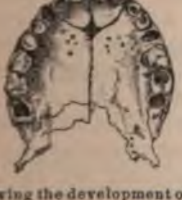
Application of twisted suture.

Wounds of the lips gape widely, and can be retained in perfect apposition only by suture. If the wound is partial, the silk or wire suture, with adhesive strip, will suffice; but if the entire lip is divided the twisted suture should be used (Fig. 388). If there is hemorrhage, apply torsion to the artery, or pass the suture-pin through it; remove the suture on the third or fourth day.

II. CONGENITAL DEFECTS OF THE LIPS.

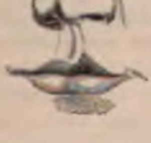
Harelip is a congenital non-union of the central, or of the central with the lateral portion of the upper lip, the cleft corresponding with the junction of the intermaxillary, or of the maxillary and intermax-

Fig. 389.



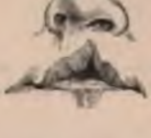
Showing the development of the intermaxillary.

Fig. 390.



Harelip congenital cicatrix.

Fig. 391.

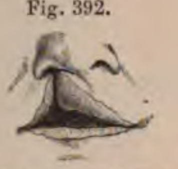


Harelip as slight notch.

illary bones (Fig. 389);[1] it is most common in males and is frequently hereditary;[2] it may be single, double, or complicated.

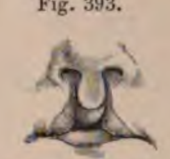
The fissure may be a slight cicatrix, the first indication of harelip (Fig. 390), or a short notch (Fig. 391); but in general it extends to within a little of the nostril, and is often continuous with it (Fig. 392); when double it may be of the same size on each side (Fig. 393), or there may be a short notch on one side and an extensive one on the other; the substance of the lip always varies much in such cases, being thick and fleshy in some and in others thin and defective in all respects, and the breadth of the gap usually varies in accordance with these characters. There is always, even in the worst cases of double cleft, an intermediate portion of lip which may be broad or narrow, long or short, thin or of the natural thickness of the lip, but generally it is deficient.

Fig. 392.



Harelip as deep fissure on right side.

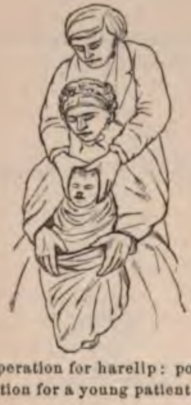
Fig. 393.



Uncomplicated double harelip.

The general rules of treatment are: (1) If the infant is feeble, delay operation until after the third month; (2) if healthy, and the cleft single, operate, if it is desired, immediately;[3] if there is no special urgency, delay till from the third month to the sixth month;[4] the comparative mortality in the different periods favors the latter course;[5] (3) when there is inability to take food, operate at the earliest moment; (4) defer the operation, if diarrhœa or eruptive diseases are present during first dentition, and in midsummer months;[6] (5) if the harelip is double, wait until the child is two or three years old,[4] unless the conditions render an earlier operation necessary; (6) chloroform is not necessary in infants. The stages of the operation are: (1) the infant, having a sheet wrapped around its body so as to inclose its arms, should be held upright in the arms of an experienced assistant, and its head firmly grasped by a second assistant (Fig. 394); the older child should recline with its head raised; (2) separate thoroughly all adhesions to the gums so that the two flaps move freely; (3) make section of the edges of the cleft with strong scissors or with the knife, and in such form as will most completely obliterate deformity when the flaps are placed in perfect apposition; (4) close the wound with harelip pins if the tension is great, and with silver-wire suture if it is but slight; introduce the suture so deeply as to reach, but not to penetrate, the mucous membrane; (5) support the flaps with long adhesive strips, or with a well-adapted truss (Fig. 395).

Fig. 394.



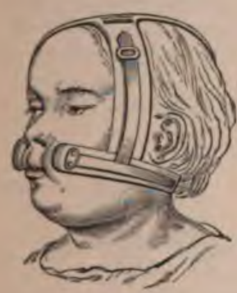
Operation for harelip: position for a young patient.[7]

---

[1] W. Froelik.
[2] C. Forster.
[3] Sir W. Fergusson.
[4] S. D. Gross.
[5] T. Bryant.
[6] F. H. Hamilton.

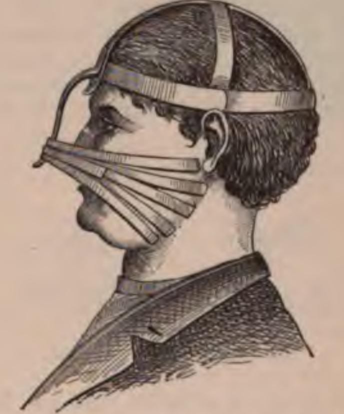
Instead of a truss for pressing the lips together a metal band may be placed around and over the head which supports an arm projecting in front of the face; adhesive strips may be applied from the cheeks over this arm so firmly as to bring the necessary support upon the lips to remove all tension on the sutures; the apparatus may be made in a few minutes by a blacksmith (Fig. 396).

Fig. 395.



Hainsby's truss.

Fig. 396.



Apparatus for drawing forward the cheeks in harelip operation.[1]

Partial fissure of the lip is best treated by two incisions[2] which meet at a point above the tip of the fissure, and extend into each flap without dividing the margins (Figs. 397, 398); the double flap thus formed is depressed, the apex presenting downwards, and the wound then becomes diamond-shaped. On closing the wound there is a pouting of the lip which gradually disappears leaving no deformity.

Fig. 397.

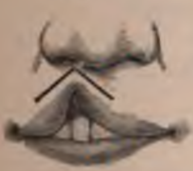
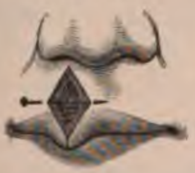
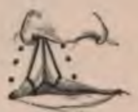


Fig. 398.



Nélaton's operation for partial harelip.

Fig. 399.



Operation for single harelip.

Single harelip may occur on either side and may vary in extent from a slight indentation to a complete division into the nostril. The two sides of the cleft differ in their regularity, being on different levels, and variously bevelled at the angles. If the knife is used, enter it at the angle and cut away a sufficient portion to make the margin straight, and secure easy and perfect adjustment; at the free border (Fig. 399) turn the edge inward to the cleft, to avoid the notch in the lip and save a portion of the mucous membrane. If the scissors are preferred, the same section can be made. If the free borders are irregular and round, the method of saving the parings[1] should be adopted, namely, make an incision from *A B* (Fig. 400) through the thickness of the lip to the free margin, which should not be divided; on the other side transfix the lip at *C* and separate a flap as far as *D*, dividing it at *E;* bring the two sides together and attach the flap *E*, *C*, to *A*, by a suture, and the flap, *E*, *D*, to *B;* apply two intermediate sutures, and the result will be a lip nearly double in depth of that obtained by the ordinary method (Fig. 401); the same result follows if the two portions, pared off the sides of the cleft, remain attached to each other (Fig. 402), as well as to the free edge of the lip, and are turned downwards and the two sides are united as before.[2] This method is peculiarly appropriate to clefts which do not extend through the whole depth of the lip, but terminate at some distance from the nostril.[3]

---

[1] W. S. Cheeseman.

[2] E. Nélaton.

Fig. 400.

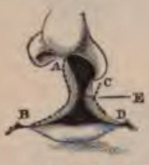
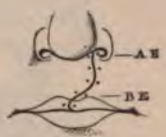
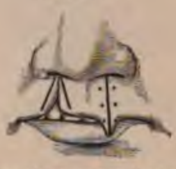


Fig. 401.



Collis's operation for harelip.

Fig. 402.



Malgaigne's operation for harelip.

In cases of very extensive cleft, or with a projection of one portion of the jaw, the following operation is advised: Cut flaps on either side (Fig. 403) and leave them attached, one *C*, by the lower, and the other *A*, by the upper end, the incision being carried around the nose as far as may be deemed necessary *E*; the flap attached by its lower end *C* is then turned downwards so that its red edge forms the border of the lip, while the other *A* is drawn upwards towards the nostril, and they are thus dovetailed together (Fig. 404) with interrupted sutures.[4]

Fig. 403.

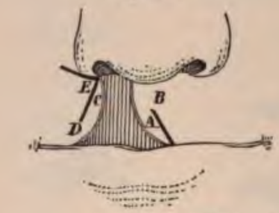
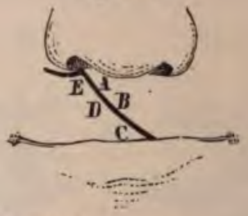


Fig. 404.



Harelip. Giraldès's method.

---

[1] M. H. Collis.

[2] M. Clémot; J. F. Malgaigne.

[3] T. Holmes.

[4] Giraldès.

In some cases the continuity of the lip border may best be preserved by the following method:[1] Remove the edge of one of the borders clearly throughout; on the other cut a flap with its pedicle below; bring the edges together so that the flap is applied from below upwards upon the notch. If the flaps in any case do not promptly unite and the edges continue to granulate, they should be maintained in apposition for the purpose of securing union by granulation.

Double harelip may exist with or without defect in the bone. When complicated with fissure of the hard palate, the best conducted operations are very liable to fail.[2] If the clefts are limited to the lips (Fig. 405), and there is not severe tension, operate upon both sides at the same time (Fig. 406); but if the traction upon the parts is great, operate upon one side at a time, making a central flap which can be attached at the sides and to the angles of the flaps (Fig. 406); first make the incisions *B* and *A*; then pare the edges of the projecting mass *C*; turn the flaps *A* and *B* downwards and unite them.

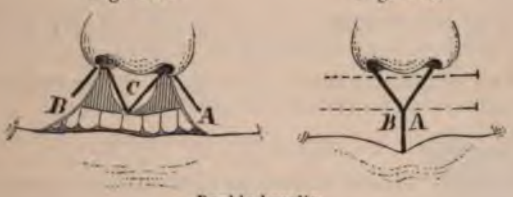


Fig. 405. Fig. 406.

Double harelip.

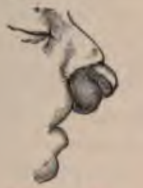
If the intermaxillary bone has not formed ossific union, it projects more or less, according to its attachments to the septum nasi. Except when it is a mere pendulous mass from the tip of the nose, efforts should be made to save it, both because it contains the sacs of the incisor teeth, and its presence is necessary to maintain the form of the upper jaw and lip.[3] In the slighter cases of projection of the intermaxillary bone it is merely necessary to fracture its attachment to the septum, and press the mass back into position, or if it be too large to fill the gap, the exuberant parts must be pared away at the sides, the adjacent sides of the superior maxillary bones refreshed, and any teeth projecting across the cleft removed.[3]

A wedge-shaped piece may be cut from the septum,[4] which allows the mass to recede more readily into the cleft (Fig. 407); a suture may be applied to the sides of this notch to retain the depressed bone in place.[5] The bone has been retained in position by silver sutures passed through it and the adjoining hard palate,[6] but three teeth were destroyed by the penetration of their sacs. The bone has been successfully held in position by at once uniting the clefts in the soft tissues.[3] When the flaps are insufficient to close the cleft, they may be dissected away from the cheek to such an extent as to admit of their easy approximation. If the process is tedious, it should be divided into stages, dealing first with the projecting intermaxillary bone, and then with the soft parts.[3] When the mass is suspended from the tip of the nose (Fig. 407), it must be removed by careful dissection with strong scissors, the soft parts being retained and so placed as to form a columna nasi, or to fill the gap in the lip (Fig. 408). The result is very favorable (Fig. 409).

---

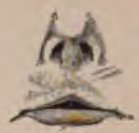
[1] Mirault.
[2] M. Guersant.
[3] T. Holmes.
[4] G. Blandin.
[5] Bruns.
[6] Von Langenbeck.

Fig. 407.



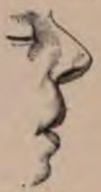
Before operation.

Fig. 408.



Front view.

Fig. 409.



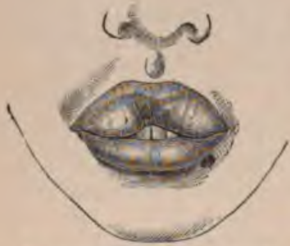
Side view (after operation).

The use of an œsophageal tube to feed the child after an operation may be employed to prevent the contact of food with the wound.

III. HYPERTROPHY OF THE LIPS.

Hypertrophy of the mucous glands is characterized by two elevated pendulous portions of tissue appearing on either side of the middle line (Fig. 410), and is due to an increase of the glands of the part and not of the mucous membrane. Make a straight or elliptical incision in the line of the lip; excise the submucous tissue; close the incision with fine sutures.[1]

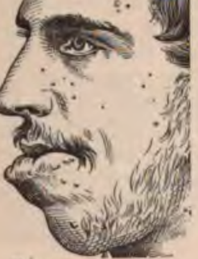
Fig. 410.



Hypertrophy of mucous glands of lips.

Hypertrophy of the lip generally occurs in scrofulous subjects, and consists in chronic thickening of the deep structures. It may result from a congenital enlargement of the capillaries constituting a nævus (Fig. 411),[2] and then has a raspberry discoloration, is flabby, pendulous, and contains hard knots in its substance. Operate as follows:[2] Remove a V-shaped patch, equi-distant from the angles of the mouth, and having its apex low down in the median line under the chin; divide the mucous membrane along the line of its reflection from the jaw on either side of the wound; bring the opposite edges of the wound together and secure them in exact co-aptation by pin sutures inserted at equal distances from each other below the lip-border; between every two pin-sutures add a silver wire, and on the vermilion border, fine thread sutures, one being on its buccal surface; when union is complete, a second operation is required to reduce the thickness of the lip. This is effected by two parallel incisions, including one-third of the thickness of the lip and

Fig. 411.



Hypertrophy of lip.

---

[1] T. Bryant.

[2] G. Buck.

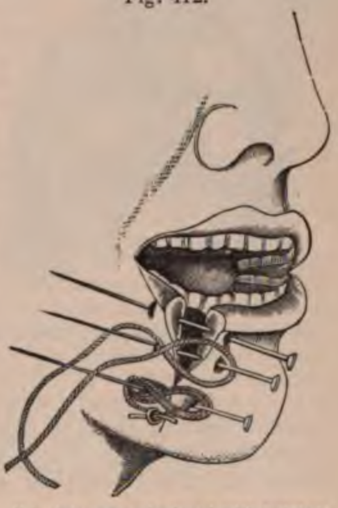
penetrating deeply into its substance; the resulting wound, well secured, rapidly heals and reduces the lip to the normal size. The raspberry color must be destroyed by the actual cautery.

IV. ACQUIRED DEFECTS OF THE LIPS.

The lips are frequently the seat of injuries and diseases which either destroy the tissues at once, or which require for their proper treatment the sacrifice of the part. The restoration or reconstruction of the lip, cheiloplasty, has now been brought to a remarkable degree of perfection.

Small growths, as a commencing epithelioma, require the V incision, closed by the twisted suture (Fig. 412). The part to be excised must be firmly held either with a hook or by forceps; make the incision exactly the same on each side completely through the lip and incline them so as to converge to a point at the base of the lip; close the bleeding vessels by torsion to avoid the presence of a ligature; bathe the surfaces with boracic acid solution, and apply two or three twisted sutures, the pins and thread being antiseptic; dust the external surface with iodoform, and apply a pad of iodoform gauzes with a bandage. The dressing should not be changed, if the case progresses favorably, until union is complete. In removing the needles rotate them first to loosen them, and while withdrawing them support the sides of the wound; adhesive rubber plaster should then be employed for support.

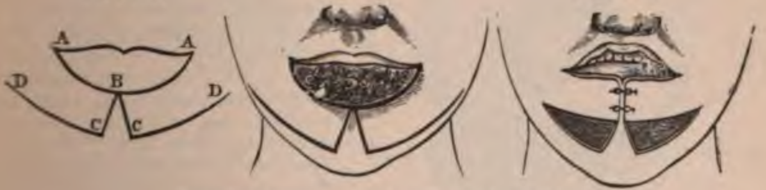
Fig. 412.



V-incision wound closed with twisted suture.

The lower lip may require nearly complete removal. Several methods of reconstruction have been devised. The most simple operation is as follows:[1] First remove the diseased part (Fig. 413)

Fig. 413. Fig. 414. Fig. 415.



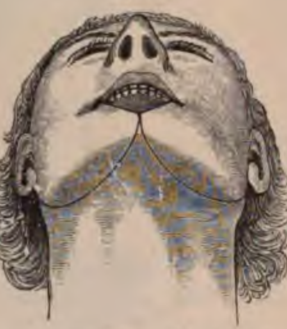
Buchanan's operation for restoration of lower lip.

---

[1] G. Buchanan.

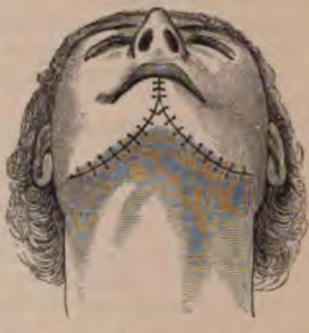
by the incision *A B A*; then make the incisions, *B C*, downwards, and outwards on each side, and the incisions, *C D*, upwards and outwards parallel to and corresponding in length to *A B*. These flaps are dissected up and brought together in the median line (Fig. 415). The uncovered places are dressed antiseptically and allowed to granulate. This operation has been modified[1] by extending the incisions, *B C*, in a curved direction under the jaw (Fig. 416); these flaps are dissected up and brought together in the middle line; the edges of the incisions are then united by suture and no raw surface is left to granulate. The result (Fig. 417) is very satisfactory.

Fig. 416.



Syme's method of restoring lower lip. Lines of incision.

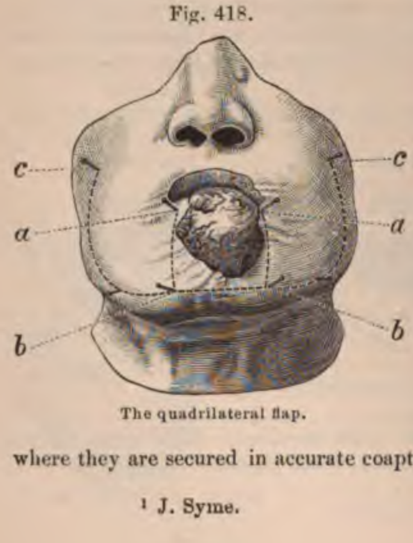
Fig. 417.



Syme's method for restoration of lower lip. Operation completed.

A quadrilateral flap may be required when a large section is removed (Fig. 418).[2] Make incisions, *a* to *b*, commencing at a point less than half an inch of each angle of the mouth, vertically downwards till they join a transverse incision *b*, *b*, crossing the lower part of the chin; dissect this flap from the periosteum; now continue the transverse incision outwards on both cheeks to a point within a finger's breadth of the angles of the jaw and thence upwards a distance of two inches in a line curving slightly forwards, *b c*, and *b c*; dissect up these cheek flaps on both sides, and divide the mucous membrane alone, along the anterior margin of the masseter muscle upwards, and thence forwards to the upper canine teeth; the two cheek flaps thus formed must be glided forwards edgewise towards each other and made to meet over the symphysis menti, where they are secured in accurate coaptation by three pin sutures and inter-

Fig. 418.



The quadrilateral flap.

---

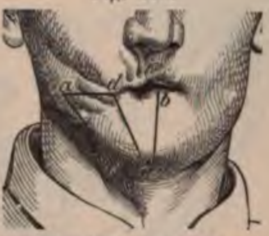
[1] J. Syme.

[2] G. Buck.

mediate fine thread sutures; close the spaces left bare by approximating the opposite edges and securing them by sutures; the facial arteries are necessarily cut and must be promptly ligated.

The lower lip and cheek destroyed by a shell wound was restored as follows (Fig. 419):[1] Two incisions were made dividing the under lip, one from *d*, and the other from *b*, converging to *c*, under the chin; this V-shaped flap was removed, including a notch upon the lip border, and the adherent portion; the remaining left half of the lip and the adjacent cheek were detached from the jaw as low down as its inferior border, and as far back as the last molar tooth; this dissection permitted the parts to glide towards the right side and in part fill the chasm left by the removal of the V-flap. The next step was to make a quadrilateral flap by the incisions *d* to *a*, and *a* to *e*, which was glided forward edgewise till it met the left half of the under lip to which it was attached; new lip border was constructed on the upper edge of the transferred cheek-patch by excising a prism-shaped strip of tissue from between the skin and mucous membrane. The mouth was also lengthened on the right side, and a border made as just described; a new angle was also made by securing the opposite edges of the divided cheek together at a point where the newly constructed upper and lower lip borders terminated; the space in the right cheek was filled by extending the transverse incision, loosening the skin and gliding it forward. At a second operation the left angle of the mouth was extended, and the result was satisfactory.

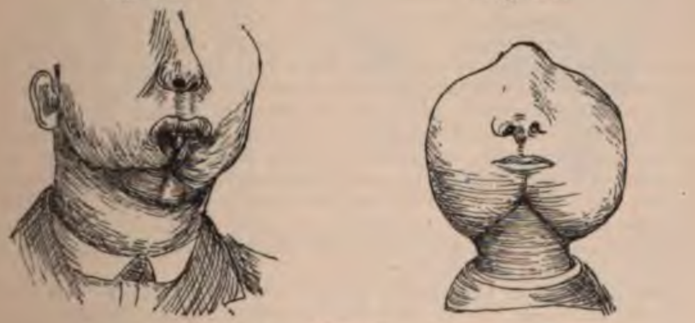
Fig. 419.



Operation for loss of cheek and lower lip.

The lower lip and chin destroyed by gunshot (Fig. 420) have been reconstructed by a similar operation.[2] The lower jaw was carried away from the second bicuspid tooth on the left, to the second molar tooth on the right. The incisions, commencing at the margin of the cicatrix, in the cleft of the lip, extended on either side to the angles of the jaw, and thence upwards to *c* (Fig. 418) until both flaps became, on loosening their deep attachments, so free as to meet readily in the median line. A useful lip resulted (Fig. 421).

Fig. 420. Fig. 421.



Operation for loss of lower lip and chin.

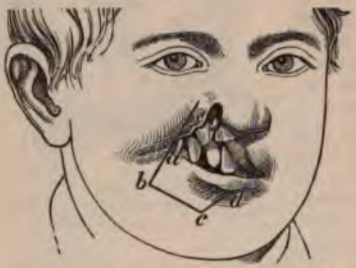
The upper lip and adjacent portion of the cheek may be reconstructed by material taken from the under lip[1] (Fig. 422), as follows: (1) Divide the extremity of the upper lip where it joins the right cheek, through its entire thickness, at right angles to its border, to the extent of one inch from the border, *a* to *b*; make a second incision from *b* to *c*, one and a half inches long, parallel to the border of the lip; fold this quadrilateral flap edgewise upon itself and to enable it to meet, and be adjusted to, the remaining half of the upper lip, divide its base obliquely half across, *c* to *d*; liberate the left half of the upper lip by incising the buccal mucous membrane along the line of its reflection from the jaw to the lip and cheek, and detaching the parts towards the orbit from the underlying periosteum on the right side; pare a strip of vermilion border from the extremity of the half lip of such length as will permit it to be matched to the free extremity of the under-lip flap; unite the two flaps in a vertical line by sutures, and close the space between the newly-adjusted half of the mouth and the neighboring cheek by approximating the opposite parts. The result, when the healing is complete, is a circular and pouting mouth (Fig. 423).

---

[1] G. Buck.

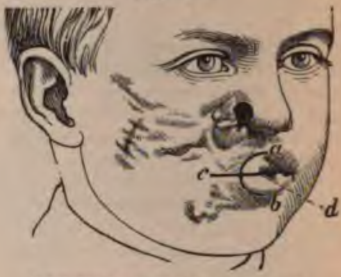
[2] J. W. S. Gouley.

Fig. 422.



Operation for loss of upper lip and cheek.

Fig. 423.



Restoration of angle of lower lip.

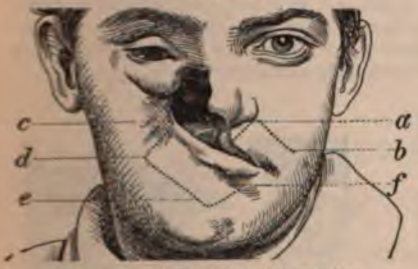
The angle of the lips is restored, as follows[1] (Fig. 423): Make an incision along the line of the vermilion border, circumscribing the circular half of the mouth and extending to an equal distance on the upper and lower lips, *a* to *b*, dividing only the skin; now insert a double-edged knife at the middle of this curved incision and direct it flatwise towards the cheek between the skin and mucous membrane, so as to separate them from each other as far as the new angle of the mouth is to be extended; divide the skin with strong scissors on a line with the commissure of the mouth outwards towards the cheek, *d* to *c*; now divide the mucous membrane on the same line, but not so far outward as the incision of the skin, and attach the angle at the terminus of the incision of the mucous membranes to the corresponding angle of the skin by a single thread suture; the fresh-cut edges of skin and mucous membrane above and below that are to form the new lip borders are to be shaped by paring so that the mucous membrane shall overlap the skin after they have been secured by fine-thread suture inserted close together.

The right half of the upper lip is reconstructed thus, after the loss of portions of the cheek, the ala nasi, and the entire superior maxilla (Fig. 424): Prepare the left half of the upper lip by incising the buccal mucous membrane along the line of its reflection from the upper jaw to the lip and cheek as far as the molar teeth; next divide the lip through its entire thickness from the point where it joins the ala nasi, on a line parallel with the lip border outwards to the middle of the cheek, *a* to *b*, and trim it square at its free extremity; prepare the redundant under lip so as to employ it for supplying the deficient right half of the upper lip according to the method described in Fig. 422, namely, by incisions from *c* to *d*, *d* to *e*, and *e* to *f* below (Fig. 424); the open space in the right cheek resulting from the transposition of the parts is closed by

[1] G. Buck.

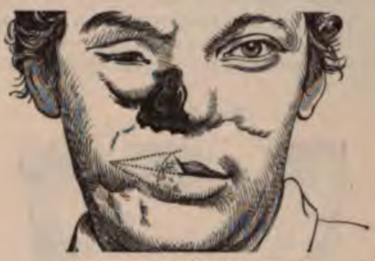
making a transverse incision through the entire cheek on a line with the commissure of the mouth as far outward as the masseter muscle, and beyond it only through the skin; by dividing the buccal mucous membrane along the anterior edge of the masseter, above and below, the cheek may be brought forward and united to the under-lip flap. The result of this operation (Fig. 425) required the restoration of the right half of the mouth; this was effected by the incisions outlined, and as described in the reconstruction of the mouth (Fig. 423). Closure of the opening in the nose was effected by another operation.

Fig. 424.



Loss of right half of upper lip.

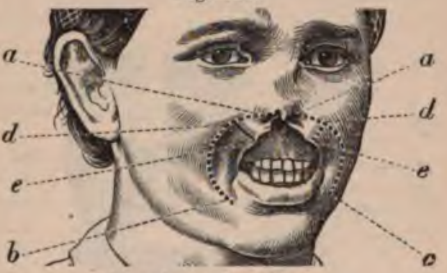
Fig. 425.



Extending angle of the mouth.

The upper lip and nose are restored thus (Fig. 426):[1] An incision through the cheeks and lip, commencing at the median line, on a level with the floor of the nasal cavity, was carried outward and downward on both sides of the face in a curved line so as to circumscribe both angles of the mouth, and terminate at a point below the junction of the middle and outer third of the under lip, *a* to *b*, *a* to *c*; those flaps were brought toward each other edgewise, and their ends being pared and made straight, were adjusted to each other on a vertical line in the median plane, and secured by three pin sutures and intermediate thread sutures; the open space was closed by detaching the mucous membrane from the cheeks, which so far liberated it that the cheeks could be readily brought forward and attached to the flaps by pin and thread sutures. The parts healed, except at the point of union of the flaps, where sloughing occurred.

Fig. 426.



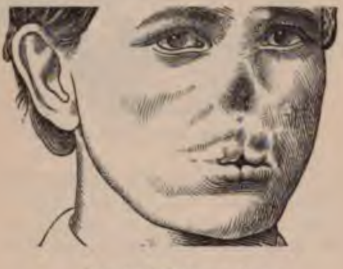
Loss of upper lip and nose.

The second operation was designed to remove the obstruction of the nostrils by a vertical incision from a point midway between the eyebrows downward upon the nose to a point on a level with the floor of the nasal cavity, from which a transverse incision was made, one inch on either side; the flaps were dissected up, the parts blocking up the nostrils were cleared away, the skin parted to correspond to the bony margin of the new opening, and left to cicatrize, which followed in due time. A third operation to improve the upper lip was performed nearly the same as the first, namely, incisions on each side of the mouth, completely through the cheek, were made from a point about half a finger's breadth below the nasal orifice, to corresponding points on each side of the chin, and at a distance of an inch from the angles of the mouth, and the border of the under lip; these flaps were brought together in the median line, and, their ends being squared, they were adjusted by suture and the gap closed as before. The results (Fig. 427) were satisfactory. The fourth operation was designed to extend the angles of the mouth, and the operation was in detail as that given (Fig. 425). A fifth and sixth operation were performed to reconstruct the nose, the flap being cut from the forehead according to a pattern carefully prepared, and turned down to its position. The final result of the several operations was entirely satisfactory (Fig. 428).

---

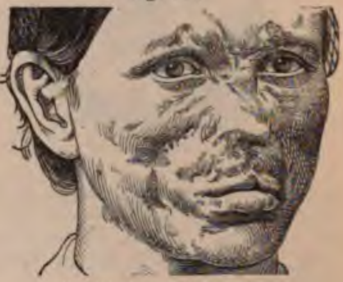
[1] G. Buck.

Fig. 427.



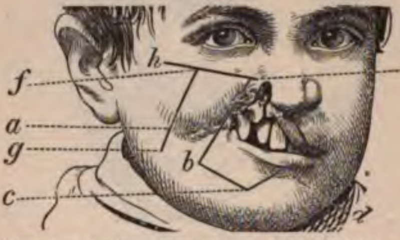
Result of first operation.

Fig. 428.



Result of second operation.

Fig. 429.



Operation for loss of upper lip and part of the nose.

The lips and the nose, after the loss of the right half of the upper lip, the adjacent portion of the cheek, and right ala nasi, were restored as follows (Fig. 429):[1] The left half of the upper lip, being held upon the stretch, was detached from the jaw by an incision of the buccal mucous membrane, carried along the line of its reflection from the jaw to the lip and cheek, and extended outwards as far as the molar teeth, and upward on the level of the periosteum towards the orbit, thus enabling the lip and cheek to be glided over to the right side; a strip of the vermilion border, an inch in length, was pared away from the extremity of the half lip and left attached temporarily; material for the deficient half of the upper lip was obtained from the redundant right half of the under lip by the incision *a*, *b*, *c*, and according to the method given (Fig. 422); this quadrilateral flap was adjusted by its free extremity when brought around edgewise to the left half of the upper lip; the open space remaining in the cheek was closed by making another quadrilateral flap, *b*, *e*, *f*, *g*, which was slid forwards edgewise and attached to the transposed under lip flap; to cover the bare surface remaining, the incision, *e*, *f*, was prolonged to *h*, and the angle, *h*, *f*, *g*, was dissected up and drawn forwards, and adjusted with sutures.

The central portion of the upper lip may be reconstructed by the following operation:[2] make two incisions, one on either side of the alæ nasi, down to the centre of the lip, and then carry the united incisions vertically through the remaining part of the lip; dissect up these flaps from their lateral attachments until they move freely, and can be approximated readily in the median line, where they are united by pin sutures, the wire suture being used for the other edges.

---

[1] G. Buck.

[2] Dieffenbach.

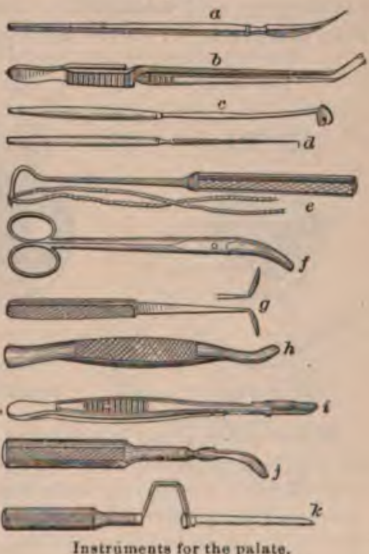
CHAPTER XXXV.

THE PALATE.

THE roof of the mouth consists of two portions, viz., the forepart, or hard, and the back part, or soft, palate; the former is covered by the periosteum and mucous membrane, which adhere intimately together; the soft palate constitutes an incomplete and movable partition between the mouth and pharynx, continued from the posterior border of the hard palate obliquely downward and backwards; it incloses muscular fibres and numerous glands.[1]

The instruments required for operations on the hard and soft palate are as follows (Fig. 430): double-edged staphyloraphy knife, *a*; seizing forceps, *b*; adjuster for wire sutures, *c*;[2] tenaculum for pulling the velum aside, or holding the edges of the flaps, *d*; spiral needles for sutures, *e*;[3] curved scissors for dividing the muscles, *f*; knives for paring the edges, *g*;[3] periosteotome, *h*,[4] or *j*;[5] wire-twisting forceps, *i*;[2] an oral saw, *k*;[5] mouth gag (Fig. 431).[3]

Fig. 430.



Instruments for the palate.

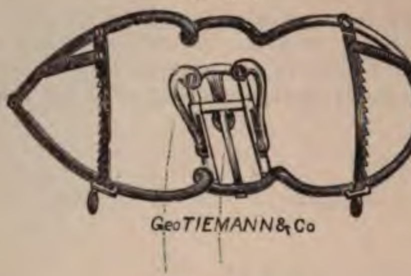
I. CONGENITAL DEFECTS.

Fissure or cleft of the palate, as a congenital defect, may involve: (1) only the uvula, 1 (Fig. 432); (2) the soft palate 2 (Fig. 432); (3) the hard palate as far forwards as the middle of the palate process of the superior maxillæ or through the palate bones only (Fig. 433); (4) the alveolar ridge entire with the cleft of the palate (Fig. 434); (5) cleft or notch of the alveolar ridge with entire cleft of palate;

---

[1] Quain's Anatomy.
[2] J. M. Sims.
[3] W. R. Whitehead.
[4] L. A. Sayre.
[5] D. H. Goodwillie.

Fig. 431.



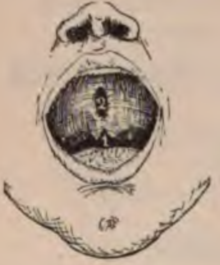
Mouth gag.

(6) double cleft of the alveolar ridge, with fissure from each running backwards and inwards and joining behind the inter-maxillary bones becoming continuous with a median fissure.

There are also many grades of separation of the fissure. Usually the cleft in the palate is narrower in front and widens towards the velum, but in some the gap will be very wide and in others very narrow, though complete from alveolus to uvula. In partial clefts the breadth is often much greater than is apparent from its extent, in some instances giving the greatest breadth met with.[1]

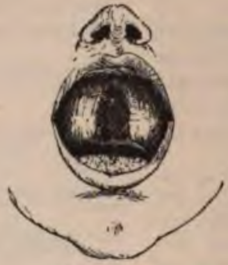
The operations undertaken for the relief of fissured palate are staphyloraphy, and uranoplasty, the former being an operation on the soft, and the latter on the hard palate.

Fig. 432.



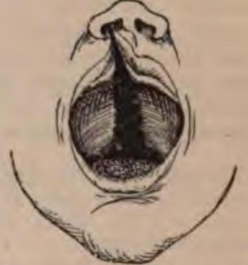
Slight fissure.

Fig. 433.



Large fissure.

Fig. 434.



Fissure of soft and hard palate.

If the uvula alone is bifid and the voice unaffected, it is better not to interfere with the fissure. As the articulation, however, is generally affected, closure by suture is the rule of treatment;[1] the operation may be performed at any age, but when circumstances are unfavorable to an early operation, it is better to defer it until the child is at least three or four years old,[2] or even until adult life.[3] If the patient is a child, chloroform should be given and the gag inserted (Fig. 434).[4]

Staphyloraphy, suture of the soft palate, is an operation which the surgeon need have no hesitation of undertaking when the cleft is limited.[1] Place the patient in a chair in a good light, first seize one point of the cleft with long spring forceps, draw it forwards, transfix it near its inner border with a narrow, sharp knife on a long handle, and freely cut upwards or downwards and remove the mucous membrane along the whole of its inner margin (Fig. 436); make the same section on the opposite side and divide the angle of union last.

---

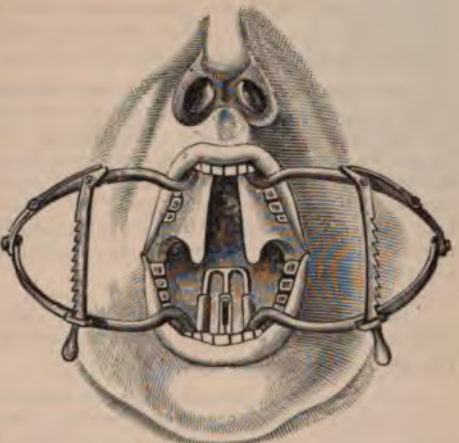
[1] G. Pollock.

[2] T. Holmes; G. Pollock; T. Bryant.

[3] Sir W. Fergusson; F. H. Hamilton.

[4] W. R. Whitehead.

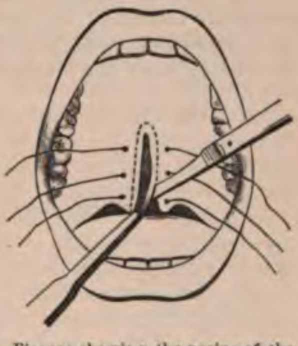
Fig. 435.



Whitehead's gag and tongue depressor.

When the cleft extends forwards through the whole of the velum, or even to a slight extent into palate bones, the operation is more complicated, for every attempt to bring the edges of the fissure together is opposed by the combined actions of the levator and tensor palati muscles, on either side, drawing directly away from the median line at which the edges of the fissure should meet; these muscles must therefore be divided to insure success.[1] The relaxation of the tissues of the fissured velum may generally be sufficiently secured by means of incisions made with strong curved scissors, so as to divide the posterior pillar of the palate just where it begins to spread out into the velum; in some cases an additional stroke or two of the scissors is necessary to divide a band of firm tissue extending above and behind the soft palate.[2] The division of the muscles is also effected as follows:[3] Pass a suture through one section of the soft palate at the root of the uvula, secure the ends by a knot, and have it held outside the mouth; repeat a similar suture on the opposite side; draw one of the sutures firmly, holding one-half of the soft palate to its opposite side so as to stretch this section of the palate towards the median line; recognize the hamular process in the substance of the soft palate internal and a very little posterior to the last molar tooth; introduce the point of a thin, narrow knife fixed in a long handle, the blade down, a little in front and to the inner side of this process and carry it upwards, backwards, and somewhat inwards, until the point is seen in the gap, having passed through the entire thickness of the soft palate, and cut partially, if not wholly, the tendon of the tensor palati; raise the handle of the knife, depressing its point, and as the blade is

Fig. 436.



Fissure showing the paring of the edges of fissure after the introduction of the sutures.

---

[1] Sir W. Fergusson.

[2] J. M. Warren.

[3] G. Pollock.

drawn forward make it cut downwards so as to pass through a considerable section of a circle on the posterior surface of the palate, by which the division of the greater portion of the levator palati is effected; complete its section as the knife is withdrawn.

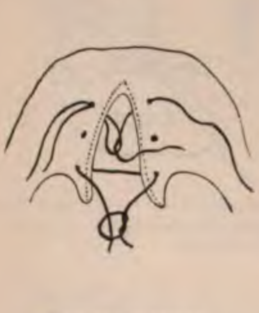
If the muscle is properly divided all movements of the palate cease, and it becomes pendulous and flaccid; if there be any further resistance, reintroduce the knife and divide the fibres more freely.[1] The divisions of the muscles may be made a day or two before the operation for closing the fissure and thus avoid the bleeding;[2] or the muscles may be divided after paring the edges, and inserting the sutures, the palate being put on the stretch by means of the threads held in the hand;[3] lateral incisions through the soft parts completely dividing the soft palate from its lateral attachments will allow the two halves to fall together.[4]

The edges of the fissures should now be thoroughly denuded of mucous membrane. The suture selected should be silkworm-gut, or Chinese silk, made antiseptic.

Of the various instruments for inserting the thread, the spiral needle, *e* (Fig. 430), is the best, but the common curved needle with a firm needle-holder, *i* (Fig. 430), may answer in emergencies.[5]

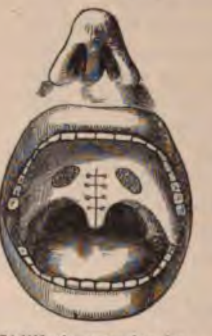
First decide how many sutures will be required, and observe the points at which they should be inserted to correspond on each side; the sutures in each needle should be at least one yard in length, and each suture should be doubled for its whole length before being passed; with the needle in the right hand and a pair of long spring forceps in the left, push the point of the needle through the soft palate on the patient's left side, as near to its anterior margin as practicable; seize one thread of the suture and draw it forwards; pass the needle on the opposite side with a double thread, the loop of which should be drawn out; the needles being removed, the single thread of the one side is passed through the loop of the other, the looped thread withdrawn from the palate carrying the single suture through the opposite side (Fig. 437);[6] repeat until the requisite number, three or

Fig. 437.



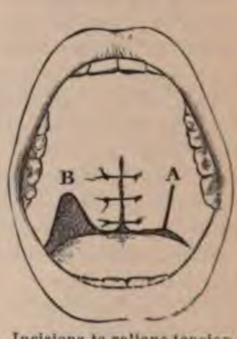
Passing the suture.

Fig. 438.



Sédillot's operation for staphyloraphy.

Fig. 439.



Incisions to relieve tension.

---

[1] G. Pollock.
[2] G. W. Callender.
[3] T. Smith.
[4] T. Bryant.
[5] F. H. Hamilton.
[6] J. Bell.

four, is inserted; tie each separately, and not too tightly, to allow for swelling; a slip-knot (Fig. 437) to bring the edges together, and a second knot over that, are sufficient (Fig. 438); the ends should not be cut off very close.[1] A perforated shot may be passed over the suture, and compressed to prevent slipping. If wire is used, it must be applied with the wire adjuster, *c* (Fig. 340), be nicely twisted, and cut closely. The after-treatment must be carefully attended to; the diet should be liquid; no conversation should be allowed; the sutures may be removed after about eight days.

To relieve tension, the soft palate may be incised (Fig. 439), the side cuts, *B*, subsequently gaping so as to appear as arches, *B*.

Uranoplasty, closure of fissure of the hard palate, may be undertaken at any age, yet as the real object of the operation is to enable the patient to articulate plainly and intelligibly, and as a child does not commence to articulate, as a rule, before twelve months old, nor to pronounce many words before two years of age, the reasons are strong against its performance prior to this latter period of life, for the child is now in a much more favorable condition to undergo the operation, and less liable to succumb to the effects of the loss of blood. The early treatment, therefore, is the proper nourishment of the infant until it reaches the requisite age, and the mother's milk is the only food that should be given for the first six or eight weeks; if the child cannot nurse, owing to the extent of the cleft, it must be hand-fed with her milk.[1] The operation, whatever may be the extent of the fissure, consists in dissecting up the membrane covering the hard palate, quite back to the alveolar processes,[2] including the periosteum so as to form muco-periosteal flaps.[3] The result will be successful in any case where the patient is fairly healthy and the parts can be brought together without undue tension.[4] The closure is effected not only by these soft tissues, but also by bone subsequently reproduced in the periosteal layer.[5] As the success of the operation depends upon immediate union of the edges of the flaps, examine the patient carefully to ascertain if he is in a condition of health to justify the expectation of union by first intention; if there are any signs of disordered health or defective power, as pustules, herpes, excoriated lips or nostrils, the operation should be postponed.[1] The operation may be completed at one,[2] or at several sittings;[1] unless there are circumstances of peculiar difficulty in the case, which will make the operation either unusually tedious or will necessitate such an extensive division of the soft parts as would endanger the flaps, the whole cleft should be closed at one operation.[4]

In an ordinary case of cleft of the hard and soft palate proceed as follows: Place the patient, etherized, in a good light; introduce the gag previously fitted to the mouth (Fig. 435); or, if the cleft is through the alveolar process also, select a gag[4] which has no central roof portion.[6] Operate first on the soft palate; pare the edges of the cleft from below upwards, the point of the uvula being held with forceps, *b* (Fig. 430), to render it tense; apply the sutures from below upwards, passing them, if possible, completely through both sides to avoid the loops described, and fastening each after the next is passed; relieve the undue tension by longitudinal incisions on either side parallel with the cleft, and just internal to the hamular process, avoiding the post palatine foramen,[1] or cut the muscles, seizing with the forceps, *b* (Fig. 430), the palato-pharyngeus muscles and dividing them with the scissors, *f* (Fig. 430), low down, and also the levator palati, of both sides.[2] When the soft palate has been closed and the point in the velum has been reached where the sutures can no longer be fastened, from the amount of tension, proceed to operate on the hard palate, if the condition of the patient do not forbid it.[1] Separate the soft tissues from the bone, commencing at the edge of the cleft and dissecting outwards to the alveolar process;[3] or, which may be preferable, from the alveolar border towards the fissure,[4] as follows: Make an incision close to and parallel with the alveolar ridge, from a point opposite the last molar tooth forwards to the canine, and separate the flaps from the bone by means of the periosteotome, *h*, *i* (Fig. 430), commencing at the incisors and proceeding inwards to the edge of the gap, avoiding bruising the flaps; these flaps should now fall inwards and downwards and meet in the median line without the slightest traction; if the edges do not readily meet, the flaps have not been sufficiently detached, and search must be made for the point preventing descent, which should be freely liberated; pare the edges with a sharp knife so that two entire and fresh raw surfaces are brought accurately in contact; pass the sutures as in closure of the soft palate. No special treatment is required, except to avoid giving warm food until the day after the operation, and to abstain from looking at the palate; give first iced milk, and afterwards, for a fortnight, such food as eggs, milk, rice milk, cream custard, stewed fruit, arrowroot, soup, beef-tea, pounded meat with wine, brandy or malt liquors;

---

[1] G. Pollock. [2] J. M. Warren. [3] Von Langenbeck.
[4] T. Smith. [5] Von Langenbeck; W. R. Whitehead. [6] J. L. Little.

Fig. 440.

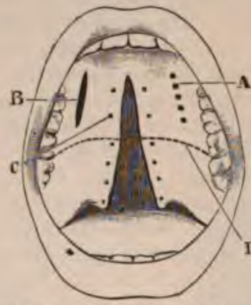
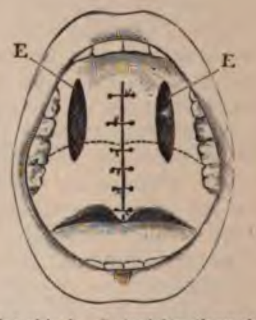


Fig. 441.



A, preliminary puncture with awl to give line for chisel. *B*, incision through bone completed by chisel. *C*, holes bored through hard and soft palates for sutures. *D*, junction of hard and soft palate. *E*, lateral openings subsequently filled up by granulation.

---

[1] T. Smith.
[2] W. R. Whitehead.
[3] J. M. Warren.
[4] G. Pollock; W. R. Whitehead; Von Langenbeck; F. Monas.

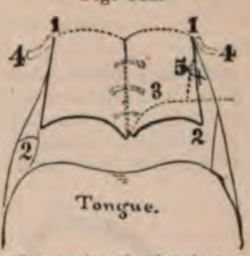
children and delicate young persons should be kept in bed for a week, when practicable; the sutures should remain three weeks or a month in children, and be removed under an anæsthetic.[1]

The following method[2] of operating has given excellent results:[3] Holes are drilled with a curved brad awl through the margins of the hard palate (Fig. 440) for the passage of the threads, while the palate itself is then cut through with a chisel in a line parallel to and about half an inch from the cleft, *B*; such step being facilitated by previously drilling the bone, *A*; this loosening of the margins of the hard palate allows the borders of the cleft to be brought together along its whole length after the margins have been pared and the stitches twisted (Fig. 341).

It frequently happens that under the most favorable circumstances a small aperture will remain; these openings are not unlike those slight congenital defects which appear in the palate as orifices, or which result from syphilitic caries; they may be closed with a metal plate,[4] or with a hard rubber obturator,[5] or by subsequent operations.[6]

II. CONTRACTION OF SOFT PALATE.

Fig. 442.



Contraction of soft palate.

Contracted soft palate frequently results from successful closure of the cleft, and leads to imperfect speech. With a view to lengthen the curtain or relieve the tension upon it, several operations have been performed: (1) The inner borders of the palato-pharyngeus muscles have been pared and united, but the operation had the effect of compelling the patient to breathe entirely through the mouth, without improving speech.[7] (2) The attachments of the palate to the sides of the fauces, together with the anterior and posterior pillars may be divided as follows: Pass a spatula behind the soft palate, 1, 2 (Fig. 442), both to steady and draw it forward, then transfix the soft palate by a sharp-pointed bistoury by the side of the spatula and at the inner edge of the hamular process, 1, 4, and cut through the free margin of the palate to 2 (Fig. 442), dividing the tensor palati, palato-glossus, and palato-pharyngeus muscles; retraction follows, 3; sutures are now passed through the sides of the flap from before backwards, thus hemming the mucous membrane, 5; this operation is extremely simple, comparatively painless, and has always resulted in some, and, in many instances marked, improvement of the voice.[8] (3) Dissection of the palato-pharyngeus muscles to form flaps in connection with a raised portion of the mucous membrane of the prevertebral region was attempted but not completed.[6]

III. THE UVULA.

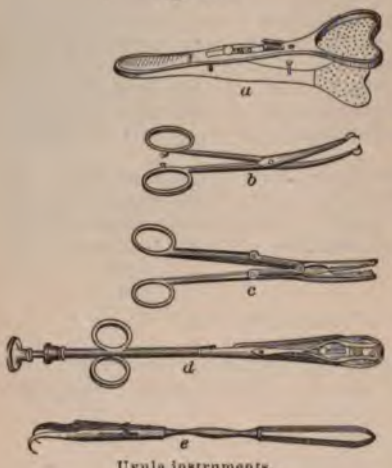
The special instruments adapted to operations on the uvula are (Fig. 443): forceps for holding the tongue, *a*; a vulsellum, *b*; uvula scissors with claws, *c*; a uvulatome, *d*; double hook, *e*.[9]

---

[1] T. Smith. [2] Sir W. Fergusson. [3] T. Bryant. [4] G. Pollock.
[5] J. M. Warren. [6] W. R. Whitehead. [7] Passavant. [8] F. Mason.
[9] H. Green.

Elongated uvula is the result of chronic inflammation; the lengthening may be slight or so great as to fall into the larynx. Excision, a very simple operation,[1] should be performed thus: The patient sitting upon a chair in front of a good light, seize the tongue with the broad spatula, *a*, or direct the patient to withdraw it from the mouth by seizing the tip enveloped in a handkerchief; seize the apex of the uvula with the forceps, *b*, or double hook, *e*, and cut off with the serrated scissors slightly curved, *c*, or uvulatome, *d* (Fig. 443), about two-thirds of the organ.

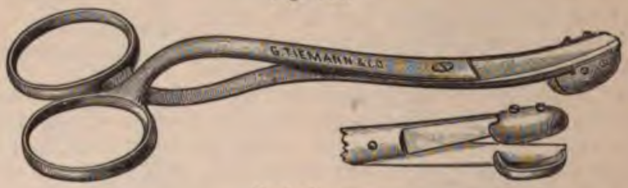
Fig. 443.



Uvula instruments.

An instrument has been devised by which the uvula may cut, and the portion removed caught in a cup-shaped appendage.[2] The handles are made long and curve upward when in position, thus facilitating an easy view of the throat; the special claim for the instrument is in the receiver beneath each blade, which is so arranged that one passes within the other, and thus all interference with the blades is avoided; no portion of the uvula or soft palate need be touched, except at the very instant of excision; no tenaculum or forceps is necessary, the severed portion of the organ being caught and retained by the instrument.

Fig. 444.



Uvula forceps.

Abscess occasionally forms in the soft palate as a result of inflammation which often extends from the tonsils; when pus is recognized, puncture with a knife having a sharp point and a narrow blade; pass this directly backwards.

Tumors appear in the soft palate, and are either fibro-cellular, cystic, or warty; the former are usually pendulous, attached to the free border or upper surface of the palate, of slow growth; remove them with forceps and scissors. Cysts result from obstructed ducts, commonly contain thin glairy fluid, and are treated by incision and the application of nitrate of silver. Warty growths springing from the mucous membrane should be removed with scissors.[3] Polypi may appear on the posterior surface, and give rise to cough owing to their pendulous condition; they may be easily removed with scissors.[4]

---

[1] S. D. Gross. [2] R. W. Knox. [3] G. Pollock. [4] S. C. Busey.

CHAPTER XXXVI.

THE ALVEOLAR PROCESS; THE SALIVARY GLANDS; THE TONSILS.

I. THE ALVEOLAR PROCESSES.

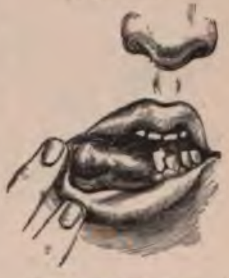
THESE parts are the thick pyramidal ridges of the maxillæ which arch from behind forward and inward; the free margins present the orifices of a number of deep conical pits, the sockets for the insertion of the teeth; the outer surface is marked by alternating vertical ridges and depressions corresponding with the alveoli and their intervals.[1]

Abscess is caused by inflammation of the alveolo-dental periosteum. A sac forms at the apex of the tooth which finally suppurates with absorption of the fluid; the gums swell and become painful, the accumulated pus ultimately makes an opening through one side of the socket, opposite the extremity of the root, the pain meantime is deep-seated and throbbing until the pus escapes.[2]

The pointing of the abscess upon the face appears to depend upon either an unusual length of fang or a superficial reflection of the mucous membrane from the jaw to cheek.[3]

In an early stage prevent suppuration by means of leeches or the extraction of the tooth or its filling; when pus is detected, puncture with a sharp-pointed knife; if it threaten to open externally, remove the tooth and make an incision between the cheek and the jaw so as to cut across the pus-containing canal, and dress the wound with oiled lint to prevent union.[3]

Fig. 445.



Epulis of lower jaw.

Epulis (Fig. 445) is a hard and densely fibrous tumor, composed of fibrous tissue and myeloid cells, and involving the periosteum; it grows slowly and evenly from the edge of the alveolar process only between two standing teeth, more often on the external than internal surface, though it may spring from any part; it generally makes its first appearance beneath and involving the little tongue of gum which exists between the necks of two continuous teeth; finally it displaces the neighboring teeth, one usually more than the other, has a broad base, which increases more the projecting portion. The treatment is early and complete extirpation, not only of the tumor, but the teeth and all the gum from which it sprang; while any part of the gum remains it is likely to recur.[4] Excision is best effected by strong cutting bone forceps. Extract the involved teeth, and then cut the process on both sides of the growth completely through the alveolar border, and remove the mass with a knife or bone nippers.

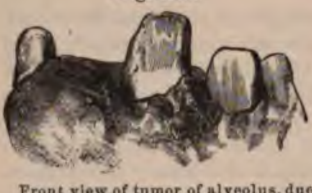
---

[1] J. Leidy. [2] C. A. Harris. [3] J. A. Salter. [4] C. A. Salter.

Under the term epulis are included, rightly or wrongly, most of the tumors of the gums, polypoid or diffused, simple outgrowths from the gums due to the irritation of a carious tooth or stump, papillary, fibrous, fibro-plastic, myeloid, epithelial, and cancerous tumors.[1]

Hypertrophy appears as a congenital affection, and consists of an expanded and prolonged development of the alveolar borders of the maxillæ, immense thickening of the fibrous tissue of the gum, and exuberant growth of the papillary surface. When fully developed, the patient presents an extraordinary appearance—a large mass, dense, inelastic, insensitive, pink, and smooth protrudes from the mouth[1] (Fig. 446). Excision should be performed.

Fig. 446.



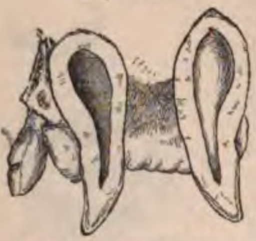
Front view of tumor of alveolus, due to hypertrophy and dilatation of tooth fang.

Vascular growths,[2] nævi, and aneurisms by anastomosis, form in the tissues about the necks of the teeth, especially between the incisors or canines and lateral incisors of the upper jaw; they have a purplish color; are smooth and streaked, with many vessels; are easily compressed and become pale and reduced, but are elastic and resume their previous aspect on removal of pressure; the whole gum is red, turgid, and swollen, and the little tongues of gum between the necks of the teeth are enlarged and spongy; troublesome hemorrhage occurs later in the disease. Excision should be performed with a scalpel, the bleeding being controlled by pressure and ice.

Warty growths[1] are hypertrophied papillæ of the gum, which occasionally appear, sometimes in connection with warts on the lips and about the face. Excision should be practised; and if there is a return caustics should be applied.

Tooth tumors,[2] odontomes, spring from the hard tissues of the teeth, and are classified as follows: (1) Enamel nodules, pearl-like tumors on the fangs; (2) exostoses, small rounded nodules near the apex of the fang; (3) hypertrophy of fangs (Fig. 447); (4) dentine excrescence, nodules of secondary dentine growing from the wall of the pulp-chamber; (5) warty teeth, the tissues being hypertrophied and folded into an irregular and complicated mass. Extraction of the affected tooth is necessary when the symptoms, as severe neuralgia, or the degree of malformation, demand interference.

Fig. 447.



Section of odontone, showing expanded thickened foot of incisor tooth.[1]

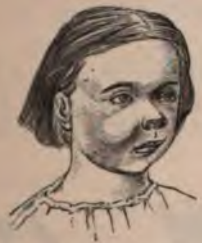
Dentigerous cysts[2] are collections of serum in the maxillary bones, dependent upon impacted misplaced teeth; they arise only when the tooth or teeth associated with them are imbedded in the substance of the jaw-bone and do not occur after the tooth has pierced the gum; they occur in connection with the permanent teeth which may fail to pierce the gum, either from the great depth of the sac, or growth in an oblique direction, or from arrest of development. The symptoms are expansion of the jawbone, weight, and tension, and disfigurement of the features (Fig. 448). The diagnosis depends on pressure, which reveals fluid, expansion of bone, and crepitation like stiff parchment, and absence of a tooth or teeth which have never appeared. The treatment consists in opening the cyst freely with knife, gouge, or trephine, extraction of the imbedded tooth, and, if the expansion is large, removal of the dilated bone (Fig. 449); the result is always satisfactory.

---

[1] T. Bryant.

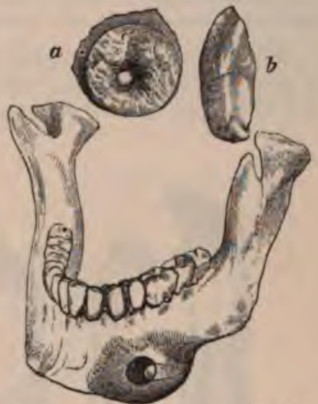
[2] J. A. Salter.

Fig. 448.



Dentigerous tumor of jaw.

Fig. 449.



Canine tooth as seen in a case of dentigerous cyst. Expanded lower jaw with tooth. b. natural size; a. bone removed by the trephine.[1]

Epithelioma occasionally appears in the gum. It soon becomes a flat ulcer, with everted edges, and finally involves the lymphatic glands. Its early removal is imperative.

The extraction of teeth,[2] though not strictly belonging to the province of the medical practitioner, must frequently be performed by him.

It is surprising that this operation should receive so little attention; this neglect can only be accounted for by the too prevailing belief that little or no skill is required for its performance; but it is the duty of every physician, residing where the services of a skilful dentist cannot always be commanded, to provide himself with the proper instruments and become acquainted with the manner of performing this operation.

The indication for the extraction of the temporary and permanent teeth are as follows:—

(1) When a tooth of replacement is about to emerge from the gums, or has actually made its appearance, either before or behind the corresponding milk tooth. (2) When the aperture formed by the loss of a temporary tooth is so narrow as to prevent the permanent tooth from acquiring its proper position without the removal of an adjoining temporary tooth. (3) Alveolar abscess, necrosis of the walls of the alveolus and incurable pain in a temporary tooth. The indications for the extraction of the permanent teeth are: (1) When a

---

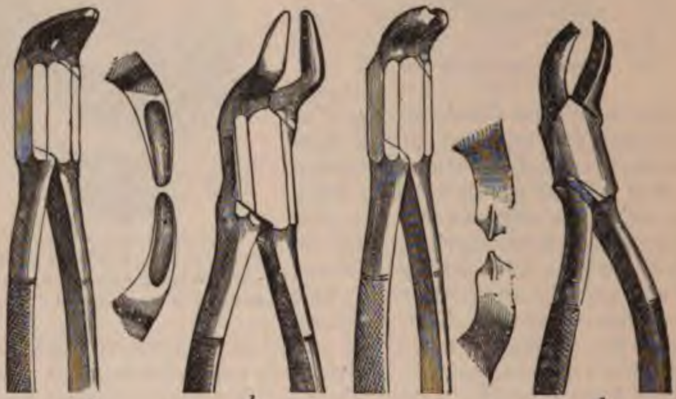
[1] T. Bryant.

[2] C. S. Harris.

molar has become partially displaced, or is a source of constant irritation; (2) when there is a constant discharge of fetid matter from the nerve cavity through a carious cavity in the crown, unless the discharge is slight, and the tooth is in the front part of the mouth and cannot be easily replaced; (3) when a tooth is the cause of an incurable alveolar abscess, unless the previous conditions exist; (4) when there is irregularity of the tooth due to disproportion between the size of the teeth and the alveolar arch; (5) when dead teeth act as irritants, or have become very much loosened.

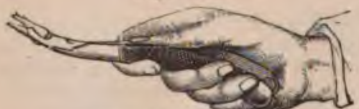
The forceps are always to be used in extraction. Though there is a great variety of forms, but four are required for general use. These are arranged in two sets, one adapted for the incisors, *a*, below, and *b*, above (Fig. 450) and cuspids, and the other for the bicuspids and molars, *c*, below, and *d*, above. Operate as follows: Detach the gum from the neck of the tooth, unless the claw of the forceps is sharp and sufficiently separates it; grasp the tooth firmly at the alveolar edge, but do not compress the handles of the forceps too tightly; move the tooth outwards and inwards, in quick succession, until it is loosened, then draw it from its socket in a line with its normal axis. The forceps must be held firmly in the hand (Fig. 451).

Fig. 450.[1]



Forceps for extraction of teeth.

Fig. 451.



Manner of holding forceps.

For the incisors, strong, straight forceps may be used, and a slight rotary motion should be given to the tooth; the cuspids require greater force, due to the length of their roots; very little rotary motion can be given to the bicuspids; the upper molars have three roots, are very firm, and must be grasped as high up as possible and pressed out and in until it yields; the superior dentes sapientiæ are usually less firmly articulated and are easily removed with the

---

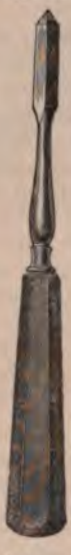
[1] Geo. Tiemann & Co.

bicuspid forceps; the inferior molars have two roots, but are very firm, and the decayed tooth is liable to be overlapped by the crowns of the adjoining teeth, which may require filing off to admit of removal; the dentes sapientiæ of the lower jaw, when situated far back, are oftentimes exceedingly difficult to extract, especially when the roots are turned posteriorly towards the coronoid process; in this case the loosened tooth should be pushed backwards, describing the segment of a circle as it is raised.

Tumors of the jaws are of every variety; those of the upper jaw being more often sarcomatous, and those of the lower jaw fibrous of some form. These tumors often become of enormous size. They are easily diagnosed, and their treatment is removal by the methods already given.

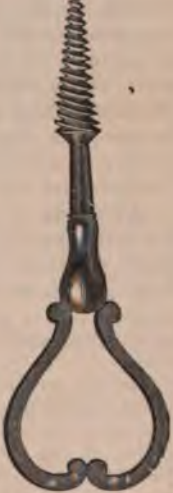
The antrum may become the seat of a variety of affections. Suppuration occurs from injury or carious teeth, attended by aching, throbbing, and lancinating pains; the pus may escape into the nostril, or it may distend the bony walls. The carious tooth should be extracted, and if relief is not obtained the cavity should be opened, either by enlarging the socket of a tooth, or by penetrating the alveolus, or through the canine fossa with a drill (Fig. 452), or a gimlet (Fig. 453). Tumors of the antrum may be cystic, polypoid, or malignant. The treatment consists in opening the antrum and the removal of the diseased structures. If the walls protrude at any point under the cheek this place should be selected for penetration either with the trocar or trephine. No external incision is required, but the cheek may require to be dissected up from the bone.

Fig. 452.



Antrum perforator.

Fig. 453.



Gimlet.

II. THE SALIVARY GLANDS.

These form a series of conglomerate glands arranged in a curved manner, and following the circumference of the inferior maxilla from the posterior border of one side to that of the other, and pouring their secretion into the mouth by means of excretory ducts.[1]

The parotid, the largest in the series, is bounded above by the zygoma; below by a line drawn backwards from the lower border of the jaw to the sterno-mastoid muscle; behind by the external meatus of the ear, the mastoid process, and sterno-mastoid muscle; its anterior border lies over the ramus of the lower jaw, and stretches forward to a variable extent on the masseter muscle; the deeper parts extend far inwards between the mastoid process and the ramus of the jaw towards the base of the skull; the excretory duct passes off from the anterior border of the gland, one finger's breadth below the zygoma, runs forwards over the masseter muscle to the anterior border, turns inwards through the fat of the cheek, pierces the buccinator muscle, runs a short distance obliquely forwards beneath the mucous membrane, and opens upon the inner surface of the cheek by a small orifice opposite the crown of the second molar tooth of the upper jaw; a line drawn from the middle of the upper lip to the meatus of the ear marks the course of the duct.[1]

---

[1] Cyclop. Anat.

The submaxillary is situated immediately below the base and the inner surface of the lower jaw and above the digastric muscle; its duct, two inches in length, passes off from the gland to the side of the frænum linguæ, where it terminates close to the duct of the opposite side by a narrow orifice which opens at the summit of a soft papilla beneath the tongue.[1]

The sublingual, the smallest gland, is situated along the floor of the mouth, where it forms a ridge between the tongue and the gums of the lower jaw, covered only by the mucous membrane, and reaching from the frænum in front, where it is in contact with the gland of the opposite side, obliquely backwards and outwards rather more than an inch and a half; the ducts[2] are from eight to twenty in number and open along the ridge which indicates the position of the gland.[1]

Wounds involving these glands are not liable to be followed by fistula, for though saliva flows for a time through the incision the textures consolidate, and the wounded part is obliterated. If oozing of saliva prevent healing, apply pressure, or touch the part with hot wire, when the fistulous opening will usually promptly close; if the excretory duct is wounded, as of the parotid gland, it is important to complete the incision into the mouth, if it has not penetrated so deeply, to allow a free escape of the saliva in that direction, and close the external wound with silver suture.[3]

Abscess may form, especially in the parotid, and generally runs an acute course with much excitement; the pain is excessive, the parts pit on pressure, there is inability to open the mouth, the fluctuation is obscure as the pus is firmly bound down by the fascia and capsule of the gland; the treatment is early and free incision, made vertically into the most prominent part.[3]

Abscess may form in the course of the ducts from obstruction by concretions; in the parotid duct it appears as a soft, fluctuating swelling in the cheek, which may attain large size, but usually ulcerates when quite small and opens externally; in the submaxillary and sublingual ducts these abscesses open into the mouth; the obstruction should, if possible, be dislodged, and the abscess opened within the mouth; if the abscess of the cheek cannot be relieved, it should be opened into the mouth, and the obstruction removed.

Calculi may form in any of the ducts of the salivary glands, but the sublingual and submaxillary are most frequently affected; they are generally of an ovoid shape, whitish color, rough, composed of phosphate and carbonate of lime with animal matter; when diagnosed they should be removed within the mouth by incision.

Ranula is a cyst beneath the tongue, usually intimately related to the salivary ducts. The ducts becoming closed, the epidermic lining is deposited in the interior, and the secretion accumulates until a large tumor is formed which presses the tongue upwards and backwards, greatly interfering with the functions of that organ. These cysts are readily recognized on inspection of the under surface of the tongue. The treatment may at first be the passing of a seton (Fig. 454) to secure drainage of the sac and adhesion of its walls. If this fail, resort to free incision, and keeping the wound open; or, excision of a portion of the walls may be necessary. If the disease persists, open the cyst and cauterize with nitrate of silver, or even nitric acid. If the cyst project in the neck, open it in the middle line below the hyoid bone, and keep it open till the cavity is obliterated.

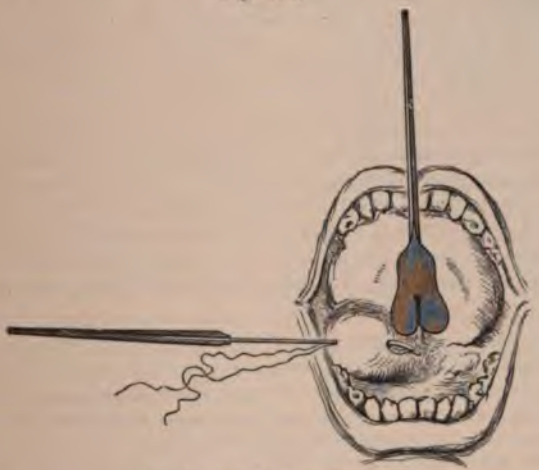
---

[1] Quain's Anat.

[2] Rivieri.

[3] J. Spence.

Fig. 454.



Ranula; introduction of seton.[1]

Fistulæ may remain after wounds or abscesses, involving either the glands or ducts, which open externally. Fistula of the gland, fully established, is often very difficult of cure. The means which may be adopted are: (1) Injections of iodine; (2) cauterization; (3) graduated compression; (4) plastic operations. When the parotid duct is implicated, the first step in the process of cure is to establish a free opening into the mouth, from the oral end of the duct.

Pass a fine wire through the opening in the mouth along the distal portion into the proximal end; the saliva will follow the wire. Or, pass a fine probe, armed with several threads of silk, into the fistula, through the duct, into the mouth either direct or through the natural opening; draw the end of the seton in the mouth out at the angle and tie it to the end on the cheek; after a week or ten days the artificial fistulous communication with the mouth will be established, and the fistula in the cheek will then probably contract and close; if it do not, cauterization of the edges of the fistula will tend to hasten cicatrization.[2] This operation failing, pass a thread of silk or metal through the fistula, into the mouth, from before backwards; remove the needle, leaving the thread in place; thread the external end and reinsert the needle at the fistula and carry it forwards in a similar manner into the mouth; remove the needle and tie the two ends of the thread now within the mouth quite firmly; the loop cuts its way out, leaving a free internal opening of the duct; the edges of the fistula may now be freshened and united by a suture.[1] Or, the fistulous tract may be destroyed by placing a wooden spatula against the inside of the cheek and with a large, sharp, saddler's punch removing it entire, and closing the external opening with a suture.[2] If the distal portion of the duct is closed, it may be opened by passing one end of a leaden wire through a puncture made at the fistula backward, and then through another puncture forward passing the other end and tying it; the saliva follows the wire, and the fistula closes.[3] Another method[4] succeeded as follows: Two fine silver wires were passed through the skin at opposite points on its edge; then the fistula, and duct for half an inch backward, were isolated by dissection; a wound was then made into the mouth, the fistular opening drawn through it and fastened by the wire.

---

[1] J. E. Erichsen.

[2] Morand; T. Bryant.

Tumors of a cartilaginous nature appear by preference in the salivary glands, especially in the submaxillary and parotid. Pure examples of enchondroma are more often found in these glands than anywhere else.[5] They may involve a single or several lobes, or the entire gland; the latter is rarely found in the parotid, but is the more frequent form in the submaxillary; other concomitant affections may also be present, especially myxoma, and sometimes cancer and cancroid.[6]

In some cases the cartilage represents merely the acme of textural evolution, while the main bulk of the growth is made up of mucous tissue, with spindle-cell and round-cell sarcoma tissue.[7] Tumors of these glands are not only cartilaginous, but are mostly encysted, and have a peculiar, hard, elastic feel, are generally imbedded in the structure of the gland, varying much in depth, those which appear movable and superficial too often dipping well down into the tissues; they may grow to a great size, and stretch the skin over them.[8]

The question of the removal of these growths must be determined by the conditions existing in each case. Pure cartilaginous tumors of small size may be very easily removed. Mixed tumors of large size involve extensive dissection among important parts, but they are often removed very satisfactorily; cancerous degeneration requires extirpation of the gland, which is always a formidable operation, but may be safely accomplished and be followed by variable periods of comparative comfort.[9] A safe rule to follow may be thus stated: When it is evident that the part glides freely over the subjacent textures, do not hesitate to undertake removal, whatever may be the bulk of the disease; but if the tumor seems fixed, its limits not clearly defined, and its movement causes pain, hesitate about removal, however small the mass may be.[10] Extirpation of a parotid tumor requires a free division of the parts as a condition essential to success; make first an incision down to the tumor and through its investments, and then add others so as to form two or more flaps; carry the dissection to the lower boundary of the growth where the vessels are known to enter, and divide, compress, or tie them, as may be necessary, and thus much less blood will be lost, and the time occupied lessened. The utmost care must be taken to avoid, as far as possible, the branches of the cervical nerves and the portio dura by dissecting the posterior part of the tumor carefully, and in the direction of their course, the edge of the knife being turned towards the tumor; in some cases these nerves must be divided.[1] Extirpation of the entire gland must be effected by similar incisions and dissections, but in deeper structures the handle of the scalpel must be used as far as possible to detach or isolate lobes of the gland or portions of the tumor and disengage them from among the vessels; tearing out the lobes is more safe than incision. In extirpating the parotid, the greatest precautions should be taken when the dissection extends behind the lower jaw, for here the external carotid and the internal and maxillary arteries are found; if exposed, they should be tied; the styloid and digastric muscles should be saved, if healthy, and cut, if involved in the disease; if the tumor finally adhere firmly at the upper part, apply a ligature to the attachments. The arteries liable to be involved are the carotid, transverse facial, temporal, auricular, mastoid, stylomastoid, occipital, internal maxillary, the inferior pharyngeal, and even the lingual and facial. The flaps should be united by suture, proper drainage being secured. The movements of the pharynx, larynx, tongue, and jaw are often permanently affected, and the muscles of the face paralyzed.[2] In extirpation of the submaxillary, make a crucial or semilunar incision of the skin over the gland, and tie and cut the vessels between two ligatures; seize the gland with a hook, draw it out and isolate it from the hypoglossal nerve and lingual artery by careful dissection; apply a ligature above the place where the gland is to be severed and separate it from its connections; close the wound accurately with suture.[3]

---

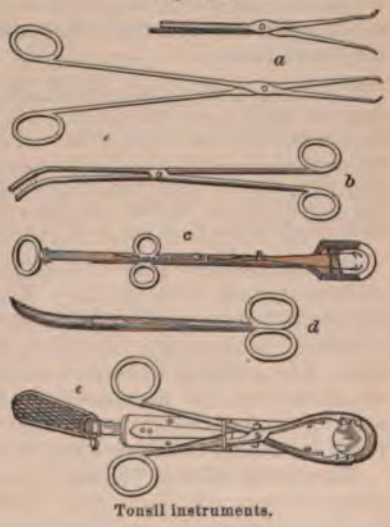
[1] J. Bell.
[2] W. E. Horner; S. D. Gross.
[3] Deguise.
[4] W. H. Van Buren.
[5] E. Rindfleisch.
[6] R. Virchow.
[7] T. Billroth.
[8] T. Bryant.
[9] J. M. Warren.
[10] Sir W. Fergusson.

III. THE TONSILS.

These bodies occupy the recesses between the anterior and posterior pillars of the fauces and are about six lines in length and four in width and thickness.

The outer side is connected with the inner surface of the superior constrictor of the pharynx, lies near the internal carotid artery, and corresponds with the angle of the lower jaw externally;[4] it is covered on the external surface by a fibrous semi-capsule which facilitates enucleation of the gland.[5] The instruments required for operations on the tonsils are as follows (Fig. 455): (1) Tenaculum forceps for seizing, *a*, or forceps with curved serrated surfaces, *b*;[6] (2) tonsillitome, *c*,[7] or *e*;[8] tonsil scissors, *d*, curved on the flat.

Fig. 455.



Tonsil instruments.

Abscess of the tonsils must

---

[1] R. Liston.
[2] A. Velpeau; V. Mott.
[3] Bernard and Huette.
[4] Quain's Anat.
[5] Chassaignac.
[6] Musseux.
[7] J. S. Billings.
[8] F. H. Hamilton.

be punctured as soon as pus is detected, care being taken to avoid wounding the internal carotid artery. Select a broad spatula and a sharp-pointed straight bistoury, wrapped to within about half an inch of its extremity; place the patient in a chair in front of a good light, the head firmly supported by an assistant; lay the spatula lightly on the tongue until the abscess is brought into view;[1] pass the knife backwards, avoiding wounding the tongue, and incline the point, when it penetrates the tonsil, towards the median line of the fauces, thus protecting the internal carotid from all danger; if the abscess cannot be sufficiently exposed it may be necessary to direct the point of the knife by the index finger of the left hand; if the abscess contain a large amount of pus the patient's head should be thrown forward immediately after the puncture to avoid the flow into the pharynx or larynx.

Hypertrophy of the tonsil is caused by repeated acute congestions of the pharyngeal mucous membrane, and consists of an equable and uniform overgrowth of all the histological elements of the follicles; the size and shape of the entire tonsil undergo an alteration; it forms a globular and often pedunculated tumor which may project so far as to interfere with breathing.[2] Removal is required only in extreme cases, as when the voice is seriously affected, or the sleep is so disturbed as to impair the health, or the secretions of the ducts are very fetid. Excision may be performed with curved hook-teeth forceps, *a*, *b* (Fig. 455), and a straight probe-pointed or curved scissors, *d* (Fig. 455), or with the tonsillitome, *c* or *e* (Fig. 455). If the patient is a child, give chloroform, and when sufficiently under its influence to open the mouth, seize the tonsil, draw it out from between the pillars, and having the knife-blade wrapped to within an inch of its point, cut away from below upward the proper amount; if an adult, place him in a chair in a good light and incise with the knife or the tonsillitome.

If the latter is used, adjust the ring to the gland on its inner and lower aspect; with the index finger ascertain that the gland is embraced by the ring; with the thumb and finger of the same hand close the forceps, draw the gland through and project the knife with the thumb of the right hand. Or, the instrument may be automatic (Fig. 456), requiring, when once applied to the tonsils, only the closure of the handles, to seize, draw out, and excise the gland; if the hemorrhage is too free, use ice applications, or ice-water gargle.

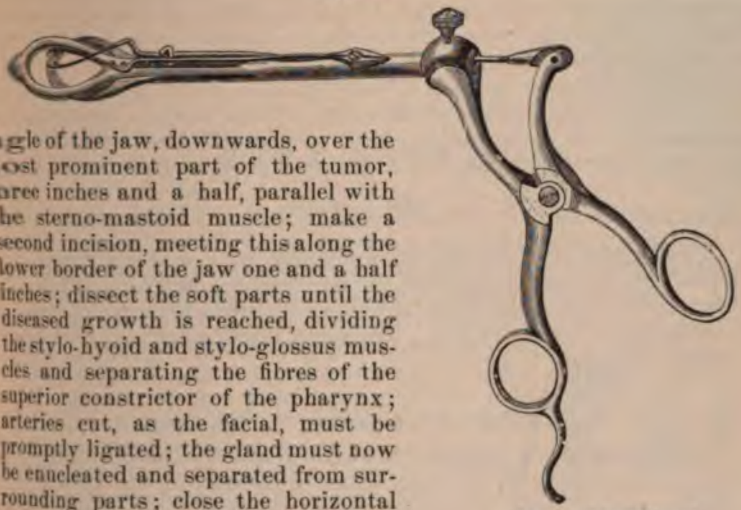
Carcinomata may appear in the tonsil as a primary or secondary disease, and has been treated by extirpation of the gland. Removal by external incision is to be preferred, for excision from within is liable to uncontrollable hemorrhage and secondary sloughing. The external operation requires great care owing to the depth of the wound, the proximity of the internal carotid artery and the crossing of the hypoglossal, gustatory, and glosso-pharyngeal nerves; there is liability to pharyngeal fistula.[3]

Excision of the tonsil requires a knife, clawed, dissecting, and artery forceps, and ligatures. The shoulders being raised and turned to the opposite side, make an incision extending from just within the

---

[1] G. Pollock. [2] E. Rindfleisch. [3] D. W. Cheever.

Fig. 456.



Automatic tonsillitome.

angle of the jaw, downwards, over the most prominent part of the tumor, three inches and a half, parallel with the sterno-mastoid muscle; make a second incision, meeting this along the lower border of the jaw one and a half inches; dissect the soft parts until the diseased growth is reached, dividing the stylo-hyoid and stylo-glossus muscles and separating the fibres of the superior constrictor of the pharynx; arteries cut, as the facial, must be promptly ligated; the gland must now be enucleated and separated from surrounding parts; close the horizontal wound with a suture, but leave the other open; liquid nourishment should be administered by the stomach-pump until the wound is sufficiently closed.[1]

Malignant growths in the region of the pharynx have recently attracted much attention, and many operations have been devised for their removal in addition to those mentioned. Though the disease is rare, yet its course is attended with so much suffering that too much effort cannot be made to alleviate the miseries of the patient. Though these operations are severe, and the disease return again, they are justifiable. If the operation is attempted, it should be before the system is infected. The method should be by external incision with a view to the complete removal of all involved glands and tissues.

A variety of operations have been practised, but they differ chiefly as to the section of the jaw. The necessity of this addition to the original operation[1] must depend upon the location and extent of the disease. The jaw may be exposed by an incision along its lower border joining one along the sterno-mastoid;[2] or by an incision along the sterno-mastoid joined by one directly backward from the angle of the mouth;[3] or by a vertical incision from the angle of the mouth to the base of the jaw, and from this point to the angle.[4] The carotid has been ligated and tracheotomy performed as a preliminary step; resection of the angle and ramus has been performed in order to obtain more room. The operation must be carefully conducted, owing to the proximity of important parts, but it does not offer any insuperable difficulties.

---

[1] D. W. Cheever.

[2] D. W. Cheever; Kocher.

[3] Polaillon.

[4] G. Maunoury.

CHAPTER XXXVII.

THE TONGUE.

The tongue is a muscular organ covered with mucous membrane; posteriorly it is connected with the hyoid bone; inferiorly it receives, from base to apex, the fibres of the genio-glossus muscle, by which it is attached to the lower jaw; the ranine arteries run along the lower surface from base to apex.[1]

I. INJURIES AND DISEASES OF THE TONGUE.

Tongue-tie is a congenital malformation in which the frænum-linguæ extends too far forwards towards the point of the tongue, and remains rather below its natural height, measured from the floor of the mouth; protrusion is hindered, and where the defect is great the tongue cannot be applied against the roof of the mouth; the slight form is harmless, but the severe form presents a great obstacle to sucking; in the latter case it is advisable to operate.[2] Division has been followed by fatal hemorrhage from the ranine arteries;[3] but carefully performed it is without danger and painless; pass[2] the first and second fingers of the left hand, palm downwards, under the tip of the tongue on either side of the frænum, and put it well on the stretch; snip the edge of the frænum with blunt-pointed scissors below the fingers, thus escaping the ranine arteries which run along the lower surface of the tongue; push the tongue upwards against the roof of the mouth, and divide further, if necessary; this method is preferable to the use of the cleft in the handle of the ordinary director.

Wounds of the tongue are liable to be followed by hemorrhage. Use styptics, ligature, or the actual cautery; these wounds unite readily. The treatment is to clean the wound of shreds, and close with sutures; if the wound is so extensive that the tongue is partially severed, it must still be united; if the tongue has a tendency to fall backwards, pass a ligature through the tip and fasten it to the teeth or externally.[4]

Glossitis is generally attended by a sudden swelling or œdema of the tongue, threatening suffocation. The remedy is free and deep longitudinal incisions; they should be made along the upper, rather than the under surface, to avoid the ranine arteries; when one side is involved the œdema may be so great as to cause the lower surface, which yields the more readily, to be turned directly upwards, when the incision must be made with great care.[5]

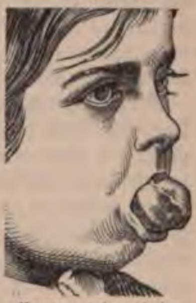
[1] Quain's Anatomy.
[2] T. Holmes.
F. H. Hamilton.
[4] S. D. Gross.
[5] H. Coote.

Polypi appear on the under surface of the tongue, as elongated growths, sensitive to the touch and the source of much annoyance; they consist of a stroma of connective tissue, infiltrated by small, round, nucleated cells, and covered by nearly normal epithelium. Excision with scissors, and injection of the base with pure acetic acid with the hypodermic syringe, have effectually destroyed them.[1]

Abscess appears as a firm tumor, imbedded in the substance of the tongue, after acute inflammation, and must be treated by incision.

Hypertrophy is usually congenital, and may be noticed immediately after birth, or may appear later, being uncertain in its rate of growth; when fully developed the tongue protrudes, with constant dribbling of saliva, and causes deformity (Fig. 457) of the jaw.[2] The treatment by pressure and astringents may first be attempted, as follows: Apply daily, cupri sulph. ℈j to aq. ℥j on lint, and compress with a bandage.[3] If these means fail, removal is the only alternative. Excision is very dangerous when the organ is great, owing to hemorrhage; the knife, ligature, écraseur, or galvano-cautery may be employed; when the knife is used the flaps may be made by transfixing the tongue laterally or vertically; the former method is, in general, preferable, as the thickness of the tongue is thereby much more reduced.[4] The head being supported against the breast of an assistant, who retracts the angles of the mouth, seize the tongue with forceps on its edges, and draw it well forward; pass a strong ligature transversely through the back part of the tongue with which to draw the organ forward; transfix the tongue from side to side at the point where excision is to be completed, and cut forward and downward, through its under surface, making the lower flap; form the upper flap by cutting in a reverse direction, backward and downward, to the point where the first section had commenced; ligate the arteries and secure the flaps in contact with sutures; recovery with a flattened tongue and good speech results.[4]

Fig. 457.[4]



Hypertrophy of the tongue.

A vertical incision may be required, in order to remove a V-shaped portion of sufficient size, and bring together the lateral flaps so as to form a new tip, which shall fall within the teeth; the patient, anæsthetized, being placed with the head elevated and held by an assistant, pass the knife through the substance of the tongue external to the middle line, to avoid the ranine artery, cut out a flap, and tie all the bleeding vessels; pass a strong ligature through this flap to prevent the tongue falling back; enter the knife at the same point; carry it across the middle lines, dividing the ranine arteries, which must be tied before the flap is finally separated; close the wound with strong sutures thus: Introduce these sutures into the lateral flaps, and on tying them the tip of the tongue assumes a natural appearance. Removal by the écraseur involves less immediate risk from hemorrhage, but is liable to be followed by dangerous inflammatory swelling. If employed, proceed thus: Pass the chain of a very stout instrument through the substance of the tongue, at the same point as in excision by the knife, and when it has worked its way outwards a little, pass a second chain and work it at the same time towards the opposite side.[1]

---

[1] S. C. Busey.
[2] T. Holmes.
[3] J. Syme.
[4] G. Buck.

Angeioma, vascular tumor, may be venous or arterial; the former are common, the latter rare. Venous angeiomas are generally congenital, may be single or multiple; usually appear on the anterior part of the dorsum, projecting slightly above the surface, thinning the mucous membrane over them, and showing a dull blue or livid color; in some the contents may be pressed out, and in others the mass feels tense and elastic like a thin cyst filled with fluid; they are usually quite painless, seldom very large, and not inconvenient except from their bulk and occasional liability to bleed. They may diminish and disappear, or increase, or undergo warty degeneration. They are composed of numerous anastomosing vessels, or are cavernous. The treatment is destruction by the actual or galvano-cautery, the latter being preferable. The point of one of the platinum instruments, at a dull-red heat, should be made to penetrate deeply into the substance of the growth and moved in all directions through it until it has been completely broken up; repeat the operation if necessary.

Papillomata, warty tumors, occur, usually, on the dorsum within the papillary area, and are then due to hypertrophy of the natural papillæ; they may grow on the under surface. They may be mistaken for condylomata, or warty carcinomata; the history of the case is the guide to a correct diagnosis in the first class, and the age of the patient and the induration of the base determine the latter. In children the hypertrophied papillæ may be destroyed by the solid nitrate of silver; the larger pedunculated growth may be removed with scissors or the ligature; the larger papillomas should be removed with the knife or scissors.

If there is the least suspicion that the growth is malignant, the base and a wide area of the surrounding tissues should be removed; these are the cases in which the best results are secured by operation; a free removal, which is yet but a trivial operation, prevents the occurrence of carcinoma, or removes it while it is a manageable disease. The treatment of the larger or doubtful warts in persons over forty years of age by caustic and other means cannot be too strongly deprecated; so far from being serviceable to the patient, it is in the highest degree detrimental; the applications irritate and excite the tumor to more rapid growth, and if it be not already cancerous, it is likely to become so under such treatment.[2]

Lipomata, fatty tumors,[2] are usually single and are situated on the border of the organ near the tip, more rarely on the dorsal aspect, and occasionally in the position of ranula, beneath the tongue. They are diagnosed by slow growth, lobulation, sense of fluctuation or extreme softness, and golden or yellowish hue. The treatment is removal. Fix the tongue by holding it with suitable forceps, incise, and enucleate the mass.

Fibromata, fibrous or fibro-cellular tumors,[2] occur more often in adults, and are generally found on the dorsum; they are composed of the softest variety of fibrous tissue; the mucous membrane is smooth and stretched, and the growth may seem to fluctuate. They resemble the fatty tumors except that they are on the dorsum and are not yellow. The treatment is the same as for the fatty tumors.

---

[1] T. Holmes.

[2] H. T. Butlin.

Cancer, in the form of squamous epithelioma, has a favorite seat in the tongue; the primary nodule is nearly always situated on one or other side of the organ, and is distinguished by its softness and tendency to seedy disintegration; on removal, it returns, and the interval between removal and return grows shorter each time until the entire tongue is destroyed. Scirrhus commences as a firm incompressible knob on the edge of the organ, often opposite the last molar tooth, or so far towards the root as to be beyond reach; the symptoms are, soreness, painful deglutition, salivation, pain in the course of the Eustachian tube, ulceration, hemorrhage, infiltration of glands.[1] Excision of the diseased part or extirpation of the entire tongue is the operation recommended.

II. EXCISION OF THE TONGUE.

Malignant diseases of the tongue are so peculiarly fatal by methods which cause intense suffering, that the removal of a part or of the whole of the organ is now a necessary operation. With improved appliances the difficulties and dangers of the operation are few and more imaginary than real.[2]

The motive to operate here is not greatly to prolong life, yet enough is gained to justify an operation which is attended with very little suffering or risk, but rather to secure future comfort, which in many cases is so great as to justify a greater risk of life than is incurred in any of the ordinary operations for the removal of cancer of the tongue; though the disease return after the operation, it is unreasonable to refuse, on that account, a painless operation, and one free from risk of life; if the patient has but two or three years to live, it is no small advantage if at least half the time can be spent in comfort rather than in misery, in profitable work rather than in painful idleness.[3]

The tongue must be removed in part or in whole according to the exigencies of the disease. The more approved methods of operating are as follows:—

The tip of the tongue[4] may be removed in whole or part with the scissors or knife; the écraseur is not necessary.

By the tip that part of the tongue is understood which is in front of the reflexion of the mucous membrane on to the floor of the mouth; practically there is a great difference in the difficulty and danger of removing the tip, and in removing the parts situated farther back, for in the former case the reflexion of the mucous membrane is not divided, and the larger vessels and extrinsic muscles are not interfered with.[4]

Chloroform having been given and the mouth opened with the gag the tongue is drawn forwards out of the mouth and retained by a pair of forceps, or by passing a stout silk ligature threaded on a sharp needle set on a handle through the front part of the tongue on one side of the middle line; a second ligature is passed through the other half tip, and the ends of each ligature are fastened together. The tongue is now drawn forwards by the operator and his assistant. Each holding one of the ligatures, the tongue is split in the middle line by incising the mucous membrane on the dorsum and under aspect, then tearing through the muscular tissue by separating the two halves with the fingers as far back as is necessary; each half is cut off separately with the scissors or knife, the vessels being tied in the first part removed before the other is attacked.

---

[1] H. Coats.

[2] W. Whitehead.

[3] Sir J. Paget.

[4] H. T. Butlin.

The anterior half of the tongue[1] may be removed by three methods, viz., 1 with scissors; 2 with the écraseur; 3 with the galvano-cautery.

(*a*) Operate with the scissors as follows:[2] Fix the mouth open to the fullest extent with a gag; direct the assistant to draw the tongue forcibly outwards and upwards with ligatures in the tip; divide all the attachments of the tongue to the jaw and to the pillars of the fauces with an ordinary pair of straight scissors; cut across by a series of successive short snips of the scissors the muscles attached to the base of the tongue, until the entire tongue is separated on the plane of the inferior border of the lower jaw, and as far back as the safety of the epiglottis will permit; apply torsion to any bleeding artery; pass a single loop of silk through the remains of the glosso-epiglottidean fold of mucous membrane as a means of drawing forwards the floor of the mouth should secondary hemorrhage occur on the first day.

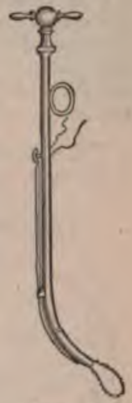
(*b*) The operation with the écraseur is as follows:[3] Introduce the gag and remove any jagged teeth; insert two ligatures an inch behind the tip, and half an inch on each side of the middle line; holding one, and the assistant the other, score the dorsum of the tongue exactly in the middle line, with a scalpel, and extend the cut well through the mucous membrane into the surface of the muscular substance and divide the tip freely down to and through the middle line of the frænum an inch beyond the level of the posterior edge of the cancer; now take the threads, one in each hand, and using the fingers much in the same way as in tightening a ligature on a deep vessel, split the tongue into two halves; pull the thread of the diseased half tightly and with blunt-pointed scissors snip the mucous membrane and the muscles which connect the tongue with the anterior part of the lower jaw as far back as may be necessary; then run the scissors along the floor of the mouth immediately beneath the mucous membrane, close to the ramus of the jaw to a point, if possible, beyond the posterior edge of the cancer; now free the tongue with snips of the scissors as completely as may be requisite from its attachments in front, at the sides, and in the floor of the mouth; the object being to free the diseased half of the tongue so that the loop of the écraseur may surround it at some distance behind the disease, and without danger of slipping forwards. One or two blunt needles are next passed through the tongue an inch or more behind the cancerous mass and the loop of the écraseur is slipped over the diseased half and adjusted behind the needles. The instrument is then screwed up and the mass severed. If the other half requires removal, the écraseur is adjusted in a similar manner.

---

[1] H. T. Butlin. [2] W. Whitehead. [3] W. Baker.

The écraseur (Fig. 458) is especially adapted to the removal of diseased structures in highly vascular tissues, as in the removal of malignant disease of the tongue, hemorrhoids, cancerous affections of the anus, uterine polypi; of the various modifications none are equal in practice to the original instrument; the resistance encountered in tightening it proves the density of tissue, every click measures accurately the progress of the chain, and it finally cuts neatly through without throwing out long shreds of tissue, leaving the operator in doubt when the tumor is entirely severed, if it is hidden from view. The difficulty of carrying the chain around the tumor when the latter is situated in the vagina or uterus, has been the only obstacle to its use; this defect is now supplied by the porte-chaine, added to the original instrument, which consists of a pair of dilating forceps with spring blades, which render the chain tense, so that it may be passed straight into the vagina or into the cavity of the uterus as easily as a sound, after which the chain is expanded by the blades of the porte-chaine.

Fig. 458.



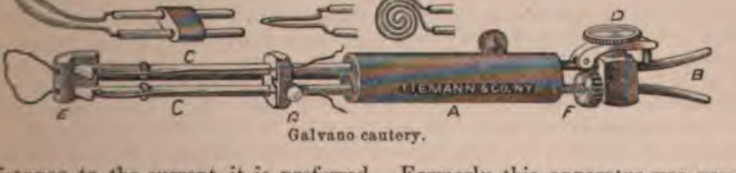
Écraseur.

(*c*) The removal of the tongue by the galvano-cautery is as follows:[1] Fix the mouth open with a gag and pass long pins, or a curved needle on handles behind the growth to isolate it from the healthy parts, and prevent the wire from slipping forwards; draw the tongue forwards as far as possible with the ligature passed through the lip; now pass the loop of the galvanic écraseur round the base of the disease, behind the pins, gradually tighten, and connect the poles of the battery. The wire should not be heated beyond a red heat, and the redness should be of a dull kind; the process of tightening should be very slowly performed, the wire being screwed home only as it becomes loose by cutting through the tissues.

When performed successfully the part to be removed will quickly fall off without the loss of a drop of blood. If bleeding follows, either the wire cautery has been at too high a temperature, or it has been screwed up too rapidly.

Galvano-cautery is cauterization by a resisting wire heated by the galvanic current; this effect is in accordance with the law of electricity, that when it passes through a resisting wire it raises the temperature in proportion to the resistance of the wire and the quantity of electricity, and the wire thus heated is capable of producing cauterizing effects; as platinum offers the greatest

Fig. 459.



Galvano cautery.

resistance to the current, it is preferred. Formerly this apparatus was very imperfect, but now a universal electrode for galvanic cautery operation is provided, which combines strength, lightness, durability, and perfect reliability, whether used as a galvanic cautery, écraseur, or cautery knife, needle or applicator; *A* is a solid hard rubber handle through which pass the conducting rods,

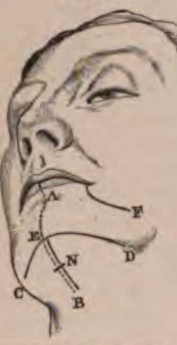
---

[1] T. Bryant.

C C, connected with the battery wires at *B*; the rods at *C C*, being hollow half their length admit of the rods running from the ivory tip, *E*, to slide in and out like a telescope, which they are made to do by turning the small wheel, *F*; this telescoping of the rods keeps up perfect current connections and at the same time causes a slow contraction of the wire cautery loops at *E*, the ends of the wire being secured in the ivory clamp *G*, in the rods *C C*; the current is regulated, or cut off and on, from the battery by the screw, *D*; three other cautery instruments of different forms may be adjusted to the handle, which are used by withdrawing the tip, *E*, with its rods, and adjusti the individual cautery, that may be requisite, with open ends of the rods, *C*

The entire tongue may be removed by the operations alrea described, but other methods are preferred by different operato (Fig. 460). The following are the sever steps of one of the earlier operations:[1] extra one of the front incisors, and make an incisio through the middle of the lip down to th hyoid bones, *A*, *B* (Fig. 460), saw throug the jaw in the same line; now pass the finge under the tongue and divide mucous lining o the mouth with the attachments of the genio hyo-glossus; while the two halves of the jaw are held apart, dissect backwards, cuttin through the hyo-glossus along with the mucou membrane covering them, so as to allow th tongue to be pulled forwards, and bring int view the situation of the lingual arteries, whic must be tied on both sides; now cut away th tongue from its attachment to the bone, protecting the knife with the finger passed over to the os hyoides; ligate arterial twigs and close the wound.[1] By the same incision the tongue may be removed with the écraseur (Fig. 461). The bones should be united by wire. The tongue may be extirpated by opening the mouth with a semilunar submental incision, *C D* (Fig. 460), and thoroughly detaching the muscles and other soft structures from the bone, and, when necessary, making also a vertical incision down to the hyoid bone (Fig. 462).[2] The écraseur may also be employed with the common wire rope, or with the galvano-caustic, as follows:—

Fig. 460.



Different operations for removal of the tongue.

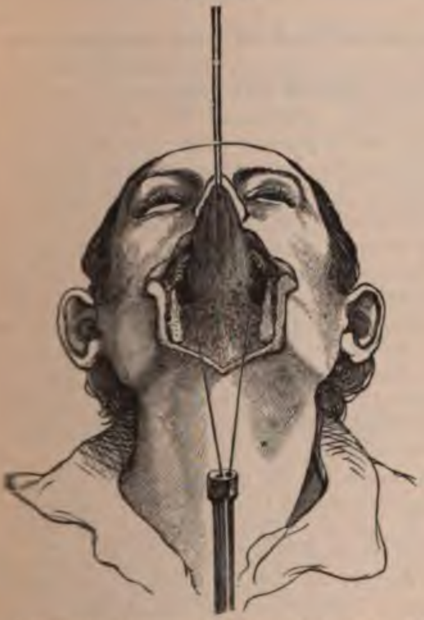
Place the patient in a semi-recumbent position without anæsthetic, and enter the knife in the median line between the base of the jaw and the hyoid bone, *N* (Fig. 460), but nearer the latter, and carry it into the mouth at the frænum linguæ, with the loop of wire; draw a good-sized loop through, and cut off the needle; pass the loop over the base of the tongue, which should be drawn forcibly forward by forceps; pass two to three long and strong harelip pins, slightly curved at the points, from the under side of the anterior attachment of the tongue, one on each side and the third in the middle, to prevent the slipping of the wire, but they are not absolutely necessary; tighten the wire slightly, and give an anæsthetic; now slowly turn the screw of the écraseur while the tongue is forcibly extended This operation has no advantages over those given where no incision was made. The sublingual tissues may be divided by the écraseur itself, additional space being gained by incising the cheek below the angle of the mouth, *F* (Fig. 463).[3]

---

[1] J. Syme. [2] E. B. Regnoli. [3] Jæger; Gant; F. Jourdan.

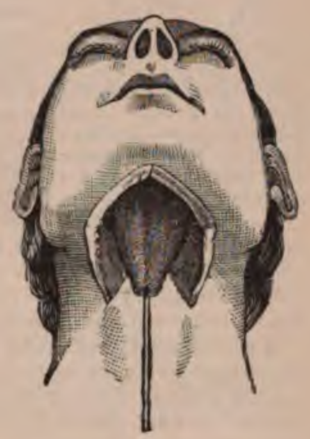
In the removal of the tongue for cancer, the ligature of the lingual artery near its origin has proved an important preliminary step, as it is less difficult than securing the vessels in the wound during the operation, prevents all hemorrhage, and may have a tendency to retard the return of the disease.[1] The following method[2] of preventing and controlling hemorrhage has been highly recommended,[3] viz., pass two fingers down behind the tongue into the pharynx and press the stump of the tongue firmly forwards; the hemorrhage is thus arrested, and the bleeding vessels are brought into view and can be readily secured.

Fig. 461.



Removal of tongue with écraseur by division of lower jaw.

Fig. 462.



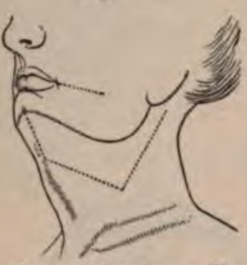
Tongue drawn out between the jaw and hyoid bone.

Excision of the tongue and lymphatic glands may be necessary completely to remove the disease. This operation may be performed as follows:[4] Perform tracheotomy and insert the ordinary canula; introduce a carbolized sponge with string attached into the pharynx to intercept all blood; make an incision from just below the tip of the ear along the anterior border of the sterno-mastoid muscle (Fig. 463) to the level of the great cornu of the hyoid bone; make another incision from this point forwards to the body of the hyoid bone; a third incision is carried along the anterior belly of the digastric muscle to the jaw. The flap is turned up on the cheek, the facial and lingual arteries tied, and the submaxillary fossa completely cleared out commencing from behind; the lymphatic, and even the salivary, glands should be removed, and all parts involved in the disease; the mylo-hyoid muscle and mucous membrane are now divided along the lower jaw sufficient to expose the tongue to its root. The tongue is drawn down through the opening, and may be removed in part or whole with scissors or the galvano-cautery.

---

[1] G. F. Shrady. [2] C. Heath. [3] H. T. Butlin. [4] Kocher.

Fig. 463.



Removal of the tongue. The dotted line in the face shows where the cheek should be split. The dotted line in the neck shows the line of Kocher's incision.

Excision of half of the tongue, a part of each jaw, submaxillary glands, and side of the pharynx, have been successfully performed for malignant disease by the following plan: an incision was made from the angle of the mouth to the submaxillary region of the left side; the facial and lingual arteries and veins were tied; the upper jaw clipped with forceps at the posterior and lower corners; the lower jaw was sawn through at the canine tooth and immediately above the angle, the tongue drawn out and transfixed with a sharp-pointed, curved bistoury, from the middle line at the hyoid bone to the base of the epiglottis, and then slit to the tip; part of the soft palate and side of the pharynx were then separated with the rest; a pharyngeal fistula remained eighteen months after the operation.[1]

The after-treatment of the stump left by excision is of great importance with reference to the final success of the operation. Fresh mouth-wounds have a tendency to become offensive owing to the contact of food and saliva with the raw surface. For the first few days therefore the patient is in danger of septic infection, either general sepsis, or septic pneumonia. The patient should at first be nourished by enemata, and thus the wound can be preserved from disturbance and contact with food. The patient should not be allowed to attempt to talk. The mouth may be kept in a state of cleanliness by weak carbolic acid solution, or permanganate of potash in solution. The wound can be dusted at intervals with iodoform, or the iodoform adhesive gauze[2] can be applied directly to the wound, where it firmly maintains its position, and completely protects the part. When the operation is preceded by tracheotomy[3] the tube may be allowed to remain in position, and the entire cavity from the entrance of the wound back into the mouth and pharynx, may be plugged with carbolic or iodoform gauze. If the wound of the tongue does not admit of being covered by gauze, iodoform should be daily applied by dusting, or by the iodoform and ether spray. With such precautions wounds of the mouth have become almost free from danger.[2]

The original adhesive gauze[2] was made as follows: Resin 900 grains, 95 per cent. alcohol 1800 grains; dissolve and add glycerine, 750 grains; impregnate 6 metres of absorbent gauze, and when half dry, rub in iodoform 750 grains. A form of adhesive gauze which has been found more serviceable in these cases may be prepared as follows: Resin 10 parts, castor oil 6, alcohol 16, iodoform 5; those ingredients mixed were sufficient to impregnate 25 parts of gauze.[4]

---

[1] R. Parker. [2] T. Billroth. [3] Kocher. [4] R. F. Weir.

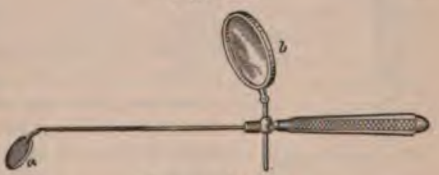
CHAPTER XXXVIII.

THE PHARYNX; THE ŒSOPHAGUS.

I. THE PHARYNX.

THE pharynx unites the cavities of the mouth and nose to the œsophagus, and extends from the base of the skull to the lower border of the cricoid cartilage, forming a sac open at the lower end and imperfect in front, where it presents apertures leading into the nose, mouth, and larynx.[1]

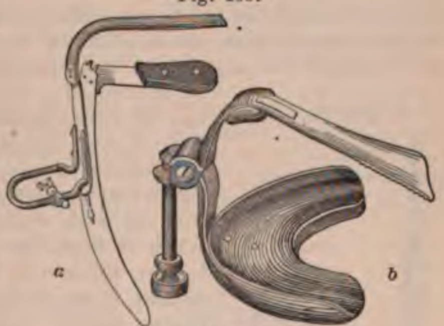
Fig. 464.



Pharyngeal mirror.

Inspection of the pharynx is so imperfectly made in the ordinary way with the common spatula or a spoon-handle, that it is important to be always provided with a suitable mirror, or reflector, which enables the operator to expose the cavity of the pharynx in the same manner as the larynx. For this purpose a simple pocket-mirror (Fig. 464) may be provided which both illuminates the pharynx by the mirror, *b*, and reflects the surface by the second mirror, *a*.[2] For thorough examination of the pharynx a tongue depressor is also required (Fig. 465).[3]

Fig. 465.



Self-acting spatula.

Wounds penetrating to the pharynx are liable to serious complications from the depth of the tube and the important parts which surround it; if the wound is free, ingesta will escape externally; if not, abscesses and sinuses are liable to form.[3] Longitudinal wounds require no other treatment than approximation by adhesive plaster, but transverse wounds should be closed if possible, by suture, while the external wound is left open.[4] If the pharynx is nearly or quite severed, the wound will be opened and food escape at every effort of deglutition; to avoid this complication, a tube, as a catheter, or that of a stomach pump, must be regularly passed down below the wound, and nourishing fluids injected into the stomach.[1]

---

[1] Quain's Anatomy.

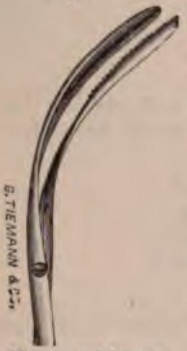
[2] L. Elsberg.

[3] L. Elsberg; W. H. Church.

[4] G. H. B. Macleod.

Abscess may form posterior to the pharynx, in front of the cervical vertebræ, in the submucous cellular tissue; it often appears in connection with caries of the vertebræ and disease of the lymphatic glands, is very insidious in its invasion, and tardy in its progress; slight difficulty of deglutition and breathing, with an inclination to snore, are often the first noticeable symptoms. On inspection, if the mouth can be opened sufficiently, a tumor is seen, of a reddish, livid, or purple color, bulging forward into the fauces, irregular in form; if examined with the finger, it will have a distinct sense of fluctuation on pressure; or the abscess may be acute, attended with deep-seated pain, great swelling, dysphagia and dyspnœa, and severe constitutional disturbance.[2] These abscesses should be opened at an early period by puncture through the mouth, either with a long, straight, narrow-bladed knife, having all of its blade protected except half an inch of its pointed extremity, or a pharyngeotome, or when it is very large, by aspiration; care should always be taken to prevent the contents of a large abscess from suddenly discharging into the larynx.

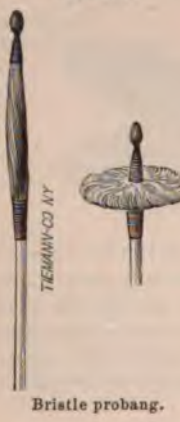
Fig. 466.



Pharyngeal forceps.

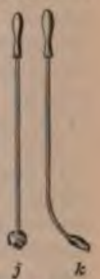
Foreign bodies, if thin and pointed, as pins, needles, fish-bones, bristles, most frequently stick between one or other of the pillars of the fauces and the tonsil, or in the mucous folds connecting the base of the tongue with the epiglottis; if more bulky, they are arrested at or about the junction of the pharynx and the œsophagus. The symptoms of a small pointed body in any of these positions are local pain, with a pricking, increased on pressure behind the angle of the jaw; sometimes there is difficulty or pain in swallowing, with a disposition to vomit; when it is at the upper orifice of the larynx there may be cough and dyspnœa; if the body is large it usually causes death.[1] In every case, instead of wiping the parts roughly with a sponge, make the most careful attempts to discover and remove the body; if it is small, and not detected by the sight or finger, use a laryngeal mirror requiring the patient to inspire deeply while the tongue is depressed; when found, seize it with properly curved forceps (Fig. 466).[1] Or, em-

Fig. 467.



Bristle probang.

Fig. 468.



Probangs.

---

[1] A. E. Durham.

[2] S. D. Gross.

ploy the bristle probang (Fig. 467), which must be introduced, closed, below the foreign body, then spread out and slowly withdrawn. If the obstructing body is food, dislodge it with the finger, or by inverting the trunk, as of a child, and giving to the back in that region a smart blow, or by forcing it downward with a probang (Fig. 468). If asphyxia is threatened, perform tracheotomy or laryngotomy. If the body is irregular, and too firmly impacted to be removed without dangerous violence, open the pharynx, even though severe symptoms are present.[1] Pharyngotomy and œsophagotomy have the same details.

Tumors may form in the pharynx. Polypoid growths from the mucous membrane may best be removed by the wire écraseur. Malignant growths in this region are very difficult of removal by operation. In general, their progress may be temporarily arrested by ligation of the carotid or its branches. The actual cautery has failed to give good results.

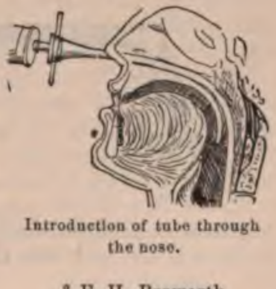
Success has attended the removal of the growths by piecemeal.[2] This was accomplished by means of the wire snare écraseur, the instrument used being the curved modification of Jarvis's snare. The snare being mounted with a No. 5 piano wire, a small loop was arranged and pressed upon a small portion of the border of the growth, and the screw being turned, the loop would bury itself in the soft tissue, and in this manner a portion perhaps not larger than a split pea is taken off. Immediately on cutting off a piece of the tumor, the parts must be showered with a weak solution of borax and carbolic acid until all pain and irritation are allayed. This process is to be continued until the entire diseased mass is removed.

II. THE ŒSOPHAGUS.

The œsophagus commences at the cricoid cartilage opposite the lower border of the fifth cervical vertebra, descends along the front of the spine, passes through the diaphragm opposite the ninth dorsal vertebra, where it ends in the cardiac orifice of the stomach; its length is nine or ten inches.

Its narrowest part is at the commencement, and it is slightly constricted at the diaphragm; it has an antero-posterior flexure corresponding with the vertebral column, and two lateral curves to the left, one just below its commencement and the second near its termination; in the neck it is nearer the left than the right side, lies close behind the trachea, and the recurrent laryngeal nerves ascend in the angles between them; on each side is the common carotid artery, the left being in more immediate connection.[3]

Fig. 469.



Introduction of tube through the nose.

Medication through the œsophagus by instruments may be effected by entering the tube at the mouth or the nostril. Catheterism of the œsophagus requires a tube about thirty inches long and the stomach-pump. Place the patient in a chair, the head thrown back, and supported by an assistant; if the tube is passed by the mouth, depress the tongue with the left index finger, or a spatula; with the fingers of the right hand take the tube, well oiled and curved, as a pen, the concavity forwards, and pass it gently along the posterior wall of the pharynx and œsophagus to the stomach, the head being thrown slighly forward as the tube descends; if the tube is passed by the nostril the patient should take the same position, and the surgeon should manipulate the tube as before, taking care to pass it cautiously along the floor of the nostril (Fig. 469) and the posterior wall of the pharynx; if the tube enter the larynx, violent symptoms, as cough and suffocation, are excited

---

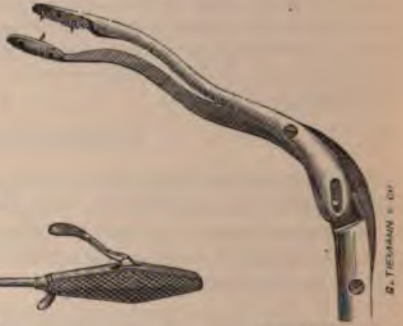
[1] E. Arnott; E. Cock; D. W. Cheever.

[2] F. H. Bosworth.

[3] Quain's Anatomy.

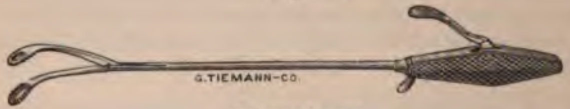
Foreign bodies are most liable to lodge opposite the cricoid cartilage, or just above the diaphragm, where the tube is most constricted; if small in bulk, but pointed, as a needle, it may stick in the mucous membrane a long time, or loosen easily by ulceration, or penetrate the walls; if large, hard, and irregular, deglutition is generally difficult, and serious results are early threatened. The diagnosis depends upon the history. External palpation rarely gives any assistance in ascertaining the presence of a foreign body lodged in the œsophagus; the tube lies so deep behind the trachea and below all of the muscles of the neck, that the hardest and most irregular substances lodged in it can very rarely be appreciated by external examination.[1]

Fig. 470.



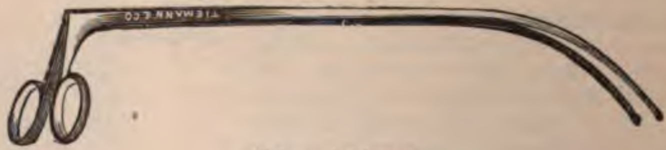
Irregular curved forceps.

Fig. 471.



Probang forceps.

Fig. 472.



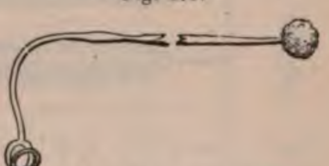
Right-angled forceps.

Attempt prompt removal; if the substance is digestible, endeavor to force it onward into the stomach by the probang; if indigestible, attempt to withdraw it by means of forceps, having a suitable curve (Figs. 470, 471, 472). Introduce them, well oiled, with the blades closed, using them as a probe, until the object is reached, when they should be opened and an attempt be made to seize the foreign body; if successful, the most careful manipulation is necessary in withdrawing it to avoid lacerating the mucous membrane; if the body is small, use a probang, to which a dry sponge is fastened, or a sound, to which a skein of silk is attached, so as to form a snare with a great number of loops, or the bristle probang (Fig. 467); these instruments should be passed beyond the obstruction and gently rotated during its withdrawal; coins and such bodies may often be extracted with a flat blunt hook connected by a thin slip of steel to the end of a long whalebone probang (Fig. 473); vomiting induced by titilating the fauces, or injecting apomorphia into the arm, will sometimes dislodge a small body, but if the obstruction is firm, excessive vomiting may fix it more firmly, or rupture the œsophagus; if respiration is dangerously embarrassed, tracheotomy must be performed, and if the obstruction is below the point of operation, a tube must be carried down the trachea sufficiently to admit the air to the lungs. When, however, a solid substance, though only of moderate size and irregular shape, has become fixed at the commencement of the œsophagus, or low down in the pharynx, and has resisted a fair trial for its extraction or displacement, its removal should at once be effected by incision into that tube, though no urgent symptoms are present.

---

[1] T. M. Markoe.

Fig. 473.



Hooks for extracting coins.

Stricture of the œsophagus is spasmodic or organic; the former occurs in hysterical persons, is intermittent, easily overcome by the probang, and disappears altogether under anæsthesia. Contractions resulting from cicatricial tissues or cancerous growth, occur chiefly on a level with the cricoid cartilage or the bifurcation of the trachea.[1] They may be linear, annular, or tubular; or the cicatrix may embrace only part of the circumference of the tube and thus form a rigid valve-like projection.[2] The leading symptom of organic stricture is gradually increasing difficulty of deglutition, with its concomitant distress and pain; if the patient is thin and the stricture high, it may sometimes be felt externally; to determine its presence and peculiarities, place the patient in a sitting posture, with the head thrown back, and pass an olive-pointed œsophageal bougie along the posterior wall of the pharynx down the tube to the seat of obstruction; the extent and condition of the stricture can now be made out. The cause may be a caustic, syphilis, or cancer; the diagnosis in the early period depends upon the history; later, simple stricture is attended with the discharge of a large amount of glairy mucus, and cancerous structure, with the escape of pus, blood, and shreds of tissue.[3] The treatment of the cicatricial form is by dilatation, œsophagotomy, or œsophagostomy, and the cancerous on the expectant plan, by resection, or by gastrostomy.[1]

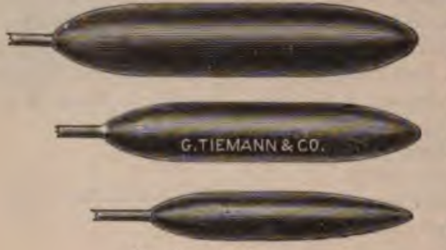
---

[1] J. Orth. [2] H. B. Sands. [3] G. B. Macleod.

Dilatation of the œsophagus requires assorted dilators.

They are made of six different graduated sizes, of hard rubber, cylindrical, tapering at both ends alike, and securely fastened to a whalebone stem (Fig. 474); they may be held in the stricture for a short time at each introduction, giving the benefit of pressure; the tolerance of these bougies by the œsophagus gradually increases, though their pressure against the larynx may interfere with respiration, and prevent their long retention within the stricture.[2]

Fig. 474.



Œsophageal dilators.

Introduce the dilator thus: place the patient in a chair, with the head thrown back; depress the tongue with the finger or a spatula, and holding the bougie as a pen, pass it along the posterior wall of the pharynx down to the obstruction, and gently insinuate the conical extremity into the contracted passage; the force used should be slight, lest the wall of the tube be perforated as has been done. The object is to open the stricture laterally and not push it downward; repeat the operation every second or third day, gradually increasing the size of the bougie as the stricture is enlarged. Dilators containing air or water are more gentle and uniform in the pressure, but difficult and uncertain in management.[3] If the stricture is unyielding and deglutition becomes impossible, internal or external œsophagotomy must be performed.

Gradual dilatation is usually the safest and best mode of treatment whenever it is practicable; it should always be resorted to as a preventive measure in the incipient stage of the disease before cicatrization has occurred; as a rule treatment should be commenced within a week or ten days of the injury and continued indefinitely.[4]

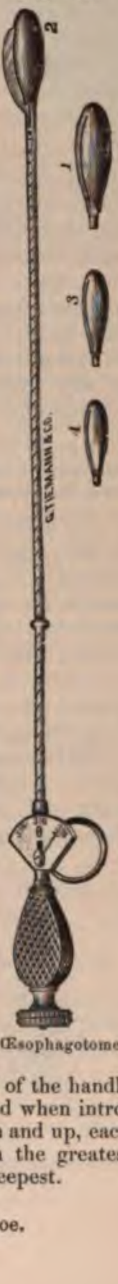
Internal œsophagotomy may be preferred when the stricture is narrow but permeable, of slight longitudinal extent, and cannot be dilated so as to permit easy deglutition.[4] Its advantages are: slight, if any, shock; power to dilate the stricture; no external wound.[3] The dangers of the operation are great owing to the thinness of the œsophageal walls, the close proximity of vital organs, and the liability of the tube to be adherent to surrounding parts.[5] The most difficult problem connected with the operation is that of exactly regulating the depth of any given internal incision; this can be done only by distending the stricture at the time when the knife is applied to it.[4]

Of ten cases, 3 died and 7 recovered; or a mortality of 30 per cent.[6]

[1] T. Bryant.
[2] J. O. Roe.
[3] B. W. Richardson.
[4] H. B. Sands.
[5] M. Mackenzie.
[6] J. Ashhurst, Jr.

The œsophagotome (Fig. 475) was devised to effect that object:[1] The shank of the instrument, which is fifteen inches and a half in length and four millimetres in diameter, is a flexible tube, made of narrow, spiral steel plate, secured within by two pieces of fine wire, in order to prevent stretching or separation of the spiral coil; the instrument is provided with a variable number of steel bulbs, each bulb being furnished with a corresponding knife-blade; the bulb is firmly fastened by a screw to the distal end of the shank, and the knife is attached to an inner flexible steel rod, manipulated by a thumb-screw at the proximal end of the instrument; by turning this screw the knife is drawn out from its concealed position within the bulb, the back of the blade sliding over a firm inclined plane; an index on a dial-plate indicates the amount of projection of the blade, the maximum projection being two millimetres and a half; a small sliding ring on the spiral tube is used to indicate the distance of the stricture from the incisor teeth; the metallic spiral tube for the shank of the instrument combines flexibility with strength; the bulb being conical, the operator can readily perceive when it comes in contact with the stricture, before he projects the blade; in operating, a bulb must be employed which exactly fits the stricture; the depth of the incision will then just equal the distance to which the blade is projected by the action of the screw in the handle.

Fig. 475.



Œsophagotome.[1]

The incision should, if possible, be from below upward. The danger of an incision from above downward is not so great in the upper as in the lower portion of the œsophagus.[2] The following conditions should in all cases be determined before the operation, viz., an opening through the stricture must be found; the œsophagus thoroughly explored to determine its exact topographic anatomical position, in relation to the location and extent of the stricture; the condition of its walls, if atrophied or thinned; the calibre of the stricture compared with that of the œsophagus above, and, if possible, below; and if the stricture be circular or located mainly or wholly on one side.

The exploration of the œsophagus is ordinarily best made with small olive-shaped balls, tapering alike at both ends, made of ivory or hard rubber, in different sizes, and mounted on a whalebone stem; a set of metallic bulbs mounted on a gum-elastic stem are of advantage in some cases, on account of their weight, as they will drop down the œsophagus by their own gravity, and, having a very flexible stem, will sometimes indicate the condition and location of a stricture more accurately than a light ball mounted on a whalebone stem, which is necessarily more or less rigid. For determining the side on which a stricture is located or is the deepest, employ an olive, which with the bulb is entirely on one side (Fig. 476); at the upper end of the handle is an indicator to show the side toward which the bulb is directed when introduced into the œsophagus; by passing the instrument gently down and up, each time turning it partly around, the side on which it meets with the greatest resistance will be indicated as the side on which the stricture is deepest.

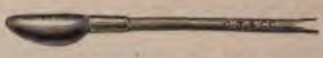
---

[1] H. B. Sands.

[2] J. O. Roe.

After the condition of the stricture is accurately determined, the depth to the upper and also to the lower side of the stricture is marked on the stem of the œsophagotome, taking the upper incisor teeth as the point to measure from. Introduce the œsophagotome, the tongue being drawn gently out and held with a napkin, until the upper mark on the stem indicates that the blade has passed through the stricture; now throw the blade out and draw the instrument out until the second mark shows that the blade has cut through the stricture, when it is thrown back and the instrument withdrawn. If the stricture has been found to be deeper on one side, turn the blade to that side; should there be more than one stricture, determine the situation of each, and divide them separately; if this cannot be done at one time, each can be successively dealt with as the passage is cleared above.

Fig. 476.



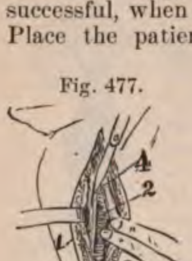
Olive-shaped œsophageal explorer.

In performing the operation it is far better and safer to make several shallow incisions at intervals, and follow each by dilatation, than to make one or two deep incisions at one time.

For a day or two after the operation the patient should be permitted to take only the blandest substances, in order to avoid irritating the wound; it may sometimes be better not to give anything by the mouth for two or three days, but to sustain the patient by nutritive enemata; the following day after the operation, dilatation should begin; without exercising force, the bougies should be gradually increased in size until the fullest extent of dilatation is attained; should the opening be then insufficient to allow complete alimentation, the operation should be repeated.

External œsophagotomy (Fig. 477), is performed for the removal of foreign bodies, and for stricture. It has proved eminently successful, when early performed, for the removal of foreign bodies.[1] Place the patient, fully anæsthetized, on the back, the head and shoulders slightly elevated, and face turned to the opposite side; if the foreign body project, make the operation at that point; if not, operate on the left side to which the œsophagus inclines. Make an incision in the course of the depression between the sterno-mastoid and the trachea, extending from about opposite the upper border of the thyroid cartilage, nearly to the sterno-clavicular articulation, through the integument; divide the platysma myoides muscle and the cervical fascia; separate the edges of the wound and draw the omo-hyoid muscle outward or cut it; divide the outermost fibres of the sterno-hyoid and thyroid to sufficient extent, 3; the carotid sheath, 2, is now fully ex-

Fig. 477.



Œsophagotomy.

---

[1] G. Pollock.

posed and should be drawn outwards with the sterno-mastoid and retained; separate the thyroid body as far as it may be necessary with the handle of the knife and draw it inwards; now draw the larynx somewhat forwards, turn it slightly upon its long axis, and pass the finger behind it to discover the position of the foreign body; if it is not found, pass a pair of long curved forceps well down into the pharynx, through the mouth, open them so as to press the walls of the tube well towards the wound as a guide, carefully avoiding the recurrent laryngeal nerve; open the tube, 1, sufficiently to admit the finger, and extend the cut upward into the pharynx, 4, or downwards along the œsophagus, as may be necessary to reach the object sought; search for the foreign body with the finger, and when found, extract it by means of suitable forceps; the wound should not be closed with sutures; for the first few days feed the patient through a tube passed by the mouth below the wound.

As rectal alimentation failed to supply a patient on whom œsophagotomy had been performed, adequate nourishment, and death was due to this cause, the plan was adopted in a second case, of supplying food directly to the stomach by means of a tube passed through the wound and dressings; this was continued ten days, and then the tube was passed through the nose to the stomach where it was retained until the wound of the œsophagus was healed; the result was very satisfactory.[1]

The incision may be made in the median line, as for tracheotomy, the sterno-hyoid muscles separated, the isthmus of the thyroid body divided between two ligatures tied around it, the left lobe turned over and the œsophagus sought and opened behind it.

Of 82 operations 63 recovered and 19 died; a mortality of about 23 per cent. In 74 of the 82 cases the foreign body was found and removed, of which 57 recovered and 17 died; a mortality also of about 23 per cent. Of 16 fatal cases of œsophagotomy 8 are stated to have died of abscess caused by the foreign body; 2 died of exhaustion; 2 of septicæmia; 1 of pneumonia; others not stated.[2]

Œsophagostomy is the establishment of a fistulous opening in the neck for the relief of stricture of the œsophagus. It should never be performed unless there is reason to believe that it will be possible to introduce a tube into the gullet below the seat of stricture.[3] The advantages are that it is attended with little shock, and facilitates the subsequent dilatation of the stricture; the disadvantages are, the doubt whether the opening will be below the stricture, the adhesion of the diseased parts to surrounding structures, and the difficulty of operating in the vicinity of large vessels, nerves, and the thyroid gland.

Of 18 cases, 4 recovered and 4 died, or a mortality of about 77 per cent.[4]

The operation is as follows:[3] Place the patient on his back with his shoulders somewhat raised, and his head turned toward the right side; an anæsthetic having been given, standing behind the patient's head, make an incision through the skin on the left side from just above the sterno-clavicular articulation to about the level of the hyoid bone; cut the platysma, and if a vein of any size, such as the external or anterior jugular, is met with, divide it between two ligatures and turn aside; slit the superficial fascia on a grooved director along the line of the original incision, and lay bare the anterior edge of the sterno-mastoid; the patient's head should then be slightly raised, so as to relax the tissues of the neck, and an assistant should draw aside the sterno-mastoid with a retractor; the omo-hyoid (which can be recognized by its direction inwards and upwards) is now brought into view, and should be divided as near to its hyoid insertion as possible; the carotid sheath is next to be held aside, together with the sterno-mastoid, whilst the trachea is drawn inwards by a second assistant; the connective tissue being torn through with the handle of the knife, the left lobe of the thyroid body should be raised and pushed towards the middle line, when the trachea will be fully exposed, together with the œsophagus behind it.

---

[1] T. M. Markoe.

[2] S. W. Gross.

[3] M. Mackenzie.

[4] J. Ashhurst, Jr.

It may sometimes be difficult to identify the latter tube, and it may be necessary, therefore, to pursue the dissection down to the pre-vertebral muscles; a sound should now, if possible, be passed from the mouth through or into the stricture; by this means the operator will be guided to the situation of the gullet, which should be opened by a vertical incision half an inch or an inch long, through its lateral wall. In cases of cancerous stricture the opening should be made as far below the seat of disease as possible, whilst in cicatricial stenosis the knife may be carried through the contracted tissues.

When the tube has been opened, a silk ligature should be passed through each edge of the œsophageal wound, and again through the corresponding lip of the cutaneous incision, and the gullet should be gently drawn towards the surface and loosely attached to the outer wound. A curved tube measuring about three inches in length below, and one above the bend, with a suitable shield at its upper extremity, should be introduced into the œsophagus through the wound, and fixed in position by means of tapes round the neck. Sutures may be used to bring the edges of the skin-wound together above and below the feeding-tube, should this appear desirable.

Combined internal and external œsophagotomy[1] has been successfully performed. The œsophagus was first opened by the ordinary cut of external œsophagotomy; from there a probe and then a director was passed through the narrowed portion, and with a herniotomy knife, guided by the director, the stricture was incised anteriorly and somewhat laterally. A catheter was then passed into the stomach, and left there for the purpose of nourishment. Later some further dilatation by bougies was accomplished.

Resection of the œsophagus is effected by the same dissection as that pursued in opening the tube. It has been performed several times successfully so far as relates to recovery from the operation, but the final results have not been satisfactory; the malignant disease has soon returned and rapidly proved fatal.

---

[1] Gussenbauer.

CHAPTER XXXIX.

THE ABDOMEN.

The abdomen is the largest cavity in the body. Though, as a whole, it includes the pelvic cavity, yet the abdomen, properly so called, extends from the diaphragm to the brim of the pelvis. The inclosing walls are formed principally of muscles and tendons, strengthened internally by a layer of fibrous tissue lying between the muscles and the peritoneum, the different parts of which are called the fascia transversalis, the fasciæ iliaca, and the anterior lumbar fascia.[1]

The degree of prominence of the abdomen varies greatly;[2] in the young its protuberance is due mainly to the relatively large size of the liver, and small size of the pelvis; in great emaciation it is sunken, especially in the upper part, where the walls just below the line of the costal cartilages, instead of being in the same plane with the anterior thoracic wall, may so sink as to be almost at right angles with that wall and with the lower part of the abdominal parietes when the patient is recumbent. The site of the umbilicus varies with the degree of obesity and laxity of the abdomen, but is always below the centre of the line between the xiphoid cartilage and the pubes. The linea alba is in the median line and has no vessels of any size. The linea semilunaris may be represented by a slightly curved line drawn from about the tip of the ninth costal cartilage to the pubic spine.

I. THE ABDOMINAL PARIETES.

Wounds involving only the abdominal walls may be of every variety described. Simple, superficial, incised, and lacerated wounds are not dangerous. The treatment should be modified by their locality. In the epigastric region a wound is prone to gape on account of the proximity of the ends of the ribs; if the muscles are cut or torn on either side transverse to the direction of their fibres, attention should be more especially directed to the position of the body to relax those muscles. Wounds in the iliac region may prove more formidable than they appear, owing to their penetration into the vicinity of large arteries;[3] carefully clear the surfaces of all foreign substances, remove any lacerated tissue which might slough, arrest all hemorrhage by the ligature or torsion, irrigate with bichloride solution, insert a catgut drain, and close the wound with (*a*) sutures taken at such depth as to firmly maintain the deeper parts in accurate apposition, and (*b*) with the continuous suture; sprinkle the surface with iodoform, and cover the parts with iodoform gauze or borated cotton; relax the abdominal muscles by position, and complete the dressings with an evenly applied bandage around the body. If the wound involve the deeper tissues, especially the thicker parts, or wherever the muscles overlap each other, it will be found difficult to maintain perfect apposition of the whole cut, and hence there is a tendency to the accumulation of serous or sanguinolent fluids between the deeper surfaces, which are liable to induce foul suppuration unless the wound is thoroughly drained. If there is severe hemorrhage, and the wound does not admit of the exposure of the bleeding vessel, enlarge it until the vessel can be seen and secured; hemorrhage need not be feared while the wound is open and a finger can be placed on the bleeding point; never close the wound and trust to external pressure without securing the artery. Disinfect the wound with bichloride solution, and firmly approximate by the quilled suture the deep parts. If the wound penetrate the walls of the abdomen, the viscera are liable to protrude. In punctured and small wounds, a part of the intestine, omentum, or both, may escape, and are very apt to be constricted at their point of exit; in incised and lacerated wounds, larger portions of viscera may protrude, and without marked constriction.[1] The hands being disinfected, the surface washed with soap and water, and irrigation with bichloride solution in progress, make a careful examination as to the nature of the protruded viscera, and the presence and adherence of foreign substances. If the protruded part is apparently omentum alone, ascertain that bowel is not concealed in the folds, or lying at the base of the protrusion. If it is healthy, being neither congested nor lacerated, it should be cleansed and disinfected, and reposited within the cavity, the wound being sufficiently enlarged, if necessary, to admit of its return. If the omentum is bruised, lacerated, dirty, inflamed, or congested, or if the mass be not considerable, but there is much resistance to its reduction, without enlarging the wound, pass a double thread through the base of the omentum and tie each half separately, then cut off all of the mass anterior to the ligature, and return the stump within the wound. With the exception of the omentum, all other protruding viscera must be returned. Intestines must be examined, and if there is no evidence of rupture or bruises, must be cleansed from dirt, hairs, or other matters, by means of tepid, disinfected water, and bichloride solution, and at once returned into the abdomen.

---

[1] Quain's Anatomy. [2] F. Treves. [3] G. Pollock.

If considerable intestine is protruding, apply sponges or towels wrung out of hot antiseptic solutions. Great care and much gentleness are requisite in handling a portion of bowel when the reduction is attempted. Observe carefully the manner in which the coils of the bowels lie with regard to the wound, and commence manipulation with the portion last descended and nearest the margin of the opening, passing up portion after portion. If reduction is difficult, owing to the distension of the bowel by gases, press the air, or, failing, puncture with an exploring needle, or better, with an aspirating needle attached to a pump or bulb-syringe, and draw off the gases; if the difficulty arise from the smallness of the wound, enlarge it to the proper size without opening the peritoneum further, in the direction of the muscular fibres, and away from the course of the epigastric or other artery. If the bowel has long been strangulated but is not gangrenous, return it at once; but if it is in a condition of gangrene establish an artificial anus.[1] It is desirable to close the wound at once, and this object is effected by first stitching the peritoneal wound with the aseptic catgut suture, then approximating the deep structures by a few sutures of antiseptic silk, wire, or worm-gut, taken deeply, and finally close the skin wound with the continuous suture. Complete with the iodoform dressings. The parts around the wound must be relaxed by position; secure uniform apposition of the edges.

---

[1] G. Pollock.

Punctured wounds are more complex and dangerous, especially when they extend below the fasciæ of the abdominal muscles, for suppuration is liable to spread rapidly in the deep cellular tissue and between the layers of muscles. If the wound penetrates through the muscles, but not the peritoneum, it may prove fatal from peritonitis immediately supervening, or secondary to the suppurative stage; the suppurative action may spread at intervals, in various directions, and repeated abscesses form in different positions and cause death by exhaustion.[1] In treatment, first control hemorrhage; if it is not sufficient to justify an enlargement of the wound in order to apply a ligature to the bleeding vessel, the outward flow should not be checked by external applications; if the hemorrhage be at all free, the wound should be enlarged sufficiently to allow the bleeding vessel to be secured, no dependence being placed on pressure to restrain hemorrhage. Blood should be carefully sponged out of the wound, and if effusion has taken place into the peritoneal cavity, enlarge the wound and cleanse the part of all blood, using all of the antiseptic precautions. Close and dress the wound as in the former case.

Abscess from injury may form in the connective tissue beneath the skin, or among the layers of the different muscles, or between the muscles and the peritoneum;[2] it may involve perforation of the bowel, especially when it commences in the cellular tissue of the loin or iliac region, where it may be slow or rapid in formation, and must be distinguished from psoas abscess, tumors, hip-joint disease.[1] Deep abscess approaches the surface very slowly, owing to the interposed structures; the symptoms are rigors, severe pain, throbbing, an indurated swelling, with œdema of the cellular tissue, indistinct fluctuation until the pus is near the surface. The early treatment should be preventive; if pus is suspected, use hypodermic syringe to explore, and, if present, evacuate it by careful exploratory incision; if the abscess is very deep the pus will have a fecal odor, though the bowels may not be injured.[2] Disinfect the cavity with carbolic or bichloride solutions, and apply iodoform dressings.

Tumors, fatty, fibrous, cystic, may form in the abdominal walls. In diagnosis, consider the history of each; examine the growth while the patient lies on the back, with thighs flexed and shoulders raised; if in the abdominal walls, it may be raised and the fingers passed under it; if the patient turns, the tumor remains fixed; but if intraperitoneal, it may float about loosely. In extirpation, make the incisions, as far as possible, in the direction of the muscular fibres; use the grooved director freely; tie all bleeding vessels as soon as divided;

---

[1] G. Pollock.

[2] S. D. Gross.

in closing the wound, unite carefully the muscular and then the tegumentary edges, so as to avoid the tendency to hernia; protect the wound by long and broad adhesive strips, a compress, and bandage.[1]

II. THE UMBILICUS.

Hemorrhage is liable to occur in the new-born, on the separation of the cord. If slight, it will be readily controlled by astringents, as by ferri persulph. or styptic cotton; if the flow continues, apply the nitrate of silver in stick. If these means fail, there is some congenital defect in the circulation of the liver which will probably prove fatal. The hemorrhage in this case is to be controlled by passing a needle under the mass and surrounding it with a ligature.

Morbid growths may appear at the umbilicus, namely, fibrous tumors, wart-like bodies, and cancer; they should not be disturbed, unless they grow, when excision may be necessary. The cancerous tumor must be removed as follows: Make two elliptical incisions in a line with the long axis of the body, which shall include the entire mass of disease; dissect carefully down to the linea alba, in healthy tissues; penetrate the linea alba, and cut around the tumor on a director; if the abdominal cavity is opened, carefully protect the intestines; close the wound with twisted suture with care, passing the pins outside of the peritoneum; close the lips of the wound with fine interrupted sutures; secure the parts with adhesive plaster, compress, and bandage.[2] Antiseptic dressings should be applied.

Fistula and abscess occur at the umbilicus. The fistula is either congenital or follows the formation of an abscess. When congenital it is due to a patent urachus, and often discharges urine. An abscess may form in the course of the urachus, due to the partial closure, and when the pus finds its way to the umbilicus it opens the tube and a fistula is the result. The fistula is frequently complicated with disturbances of the genito-urinary tract, viz., cystitis, polypus of the bladder, calculus, phimosis, pyelo-nephritis, hydro-nephrosis; any cause of obstruction to the free discharge of urine from the bladder is liable to create a urachal fistula or abscess by opening the tube. The treatment should aim to overcome any existing conditions which cause a set back of the urine. Circumcision in phimosis, the dilatation of a narrow urethra, the cure of cystitis or its relief by cystotomy, are among the resources of the surgeon. If the fistula is a constant outlet for pus or urine it should not be closed, but if the discharge is slight and inconstant, a ligature may be applied to the papillary growth from which the discharge takes place, or nitric acid may be applied, or the skin may be dissected off around the opening, and the wound closed with the twisted suture.

III. THE PERITONEUM.

The internal layer of the abdominal parietes is the peritoneum, an extensive and complicated serous membrane having important relations to the viscera of the abdomen. It is not only liable to the injuries and diseases peculiar to serous membranes, but is generally implicated in the diseases of the viscera which it overlies. The affections of the peritoneum amenable to surgical treatment are ascites and peritonitis.

---

[1] S. D. Gross.

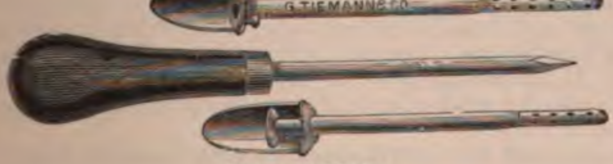
[2] W. Parker.

(*a*) **Ascites,** abdominal dropsy, is an accumulation of fluid in the cavity of the peritoneum, and may be due to chronic inflammation of this membrane, or to disease of the liver, kidney, or heart. The surgical treatment of ascites has hitherto consisted in removing the fluid from the cavity of the peritoneum, to relieve the pressure which is made upon vital organs. It has, however, not unfreqently happened that after the evacuation of the cavity the dropsy has not returned. This result has followed tapping when the dropsy was due to a low grade of inflammation of the peritoneum, or to local conditions of inflammation which were relieved by the removal of the accumulated fluid. This experience suggests the importance, not only of early and repeated tapping in ascites, but of incision and drainage, and even of exploration of the cavity in the more severe and persistent cases.

Let tapping be resorted to as soon as the dropsy occasions notable inconvenience; let all causes be removed as far and as soon as possible; let the patient be placed on a tonic and analeptic treatment; let depressing and purturbating drugs be avoided; let the tapping be promptly repeated if the dropsy return, and notwithstanding the existence of a certain amount of cirrhosis there may be a restoration to fair general health, and its continuance to an indefinite period.[1]

Aspiration of the cavity of the peritoneum is the most simple method of removing the fluid. The instrument most convenient and well-adapted for the purpose[1] is the common syringe with a bulb.[2] Attach a large aspirating needle to the end of the tube; place the patient in the position for paracentesis, and provide the bandage for the abdomen in the same manner; evacuate the bladder; make a small incision through the skin; in the median line, about two or three inches above the symphysis pubis; insert the needle with a slight boring motion until it is free in the cavity; now compress the bulb as in the ordinary operations of the syringe, and pump the water into a vessel. Close the wound with adhesive plaster.

Fig. 478.



Trocar and canula.

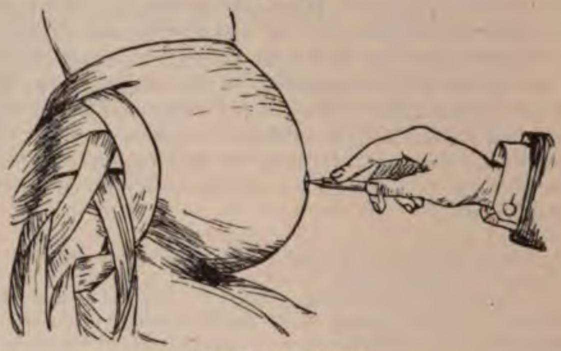
Paracentesis abdominis should be performed as follows: The best instruments for the operation consist of a trocar and canula, and a catheter closed at the end but perforated on the sides by numerous holes (Fig. 478).[1] The trocar, in the canula, is thrust into the cavit and then withdrawn, leaving the canula in position ; the trocar bein withdrawn, the perforated catheter is introduced; the fluid now flow without the possibility of obstruction by the prolapsus of the ome tum over the end of the tube, as always occurs with the old canul Place the patient in a sitting position, or upon the side of the ed of the table (Fig. 479) ; surround the body with a bandage sufficientl wide to cover the abdomen; tear the ends and make them overlap behind; take the trocar or needle in the right hand, the index finger being applied to the shaft within an inch of the point; select a place two or three inches above the pubes, in the linea alba, and make an incision through the skin with the point of the scalpel; through this incision introduce the trocar, with a slight boring motion, until the extremity is free in the cavity; grasp the canula with the left hand, and hold it firmly while the trocar is withdrawn; push the canula farther into the cavity, and, if there is a perforated canula, introduce it into the open canula; while the fluid is escaping, assistants should gradually tighten the bandage behind; when the fluid is all removed, remove the canula instantly. Compress the edges of the opening with thumb and finger, and apply two long adhesive strips, crossing at the seat of puncture, and pin the bandage in place. If the fluid stops suddenly, before sufficient is removed, and no perforated internal canula is at hand, introduce a probe cautiously to dislodge any floating substance or omentum which may occlude the end of the canula. If the patient faint, arrest the flow by placing the finger over the opening while stimulants are administered, or a hypodermic injection of brandy.

---

[1] A. Flint.

[2] Davidson.

Fig. 479.



Tapping the abdomen.

Drainage of the peritoneal cavity in ascites has often followed tapping, due to a failure of the puncture to heal. The result has, in some instances, proved favorable ; the accumulating fluid has constantly escaped, and peritonitis has not supervened. Exploratory incision of the abdomen in ascites has often in itself proved curative.[2]

---

[1] J. A. Wood.

[2] L. Tait.

It is proper, therefore, to infer that drainage of the peritoneal cavity will, in many cases, prove to be the proper treatment.

In several instances of drainage the result was entirely favorable;[1] the cases selected are those in which the dropsy is due to hepatic, renal, and cardiac diseases, cancer and tuberculosis of the peritoneum, and chronic peritonitis. The operation consists in making an incision one inch in length in the linea alba, and introducing an aseptic rubber tube through a canula one inch within the cavity, and fastening it externally by a safety pin; the external end of the tube was protected by iodoform gauze and dry towels, and the skin was covered with linen smeared with tallow or iodoform ointment. The outer end of the tube may terminate in a tube which leads into a vessel.

(*a*) Peritonitis may be caused by injuries, or diseases, or by diseases of the viscera of the abdomen. It may be general or local, sthenic or asthenic, serous, plastic, or purulent. The distinction between these forms which has hitherto interested the surgeon has been the latter, viz., whether the inflammation was serous, plastic, or purulent. In the former cases no other operation was proposed than the remote one of evacuation of accumulated fluid, while the latter might justify incision to evacuate pus. The distinction cannot be made with great precision, and experience proves that many cases might have been saved by timely interference.

No sharp line can be drawn between sero-fibrinous and purulent inflammation, for various intermediate or fibrino-purulent varieties occur in which the exudation is pus-like, while at the same time it contains soft white cellular flakes and curds of fibrin; the exudation sometimes becomes putrid, or discolored and foul smelling; this is most apt to occur in abdominal inflammation, depending on septic processes in the uterus or its appendages, or on the escape of fecal matters from the intestines; the putrid exudations contain multitudes of micrococci, single or in chaplets, and occasionally microbacteria; the pus-corpuscles of the exudation rapidly become fatty and break down; death often intervenes while the inflammation is at its height.[2]

The treatment of peritonitis, in all its forms, has hitherto been very unsatisfactory, for it aimed at little else than mitigating symptoms by empirical remedies. Among the more important advances in surgery must be included that which has brought inflammation of the peritoneum under the control of operative procedures. There can be no doubt that the treatment best adapted to rescue a patient from the perils of purulent peritonitis is section of the abdominal walls, and thorough cleansing and disinfection of the peritoneal cavity. But as it has been found impossible to correctly diagnose the precise changes that have taken place in the peritoneum in the progress of the inflammation, and as drainage of the cavity has proved highly beneficial, it is now proposed[3] to open the abdomen in all cases of peritonitis, even if puerperal, wash out the cavity, and drain it thoroughly.

The success of drainage in saving many of the cases which formerly died, proves that if we remove from the peritoneal cavity material which is over and above its absorptive power, or if we remove in a similar way its own effusion, under circumstances where its absorptive power is temporarily in abeyance and threatening, with the life of the patient to be permanently destroyed, we can put a stop to all the trouble; whilst there are cases of peritonitis which are really septic, that is, when some kind of poison gets into the peritoneum and speedily affects the whole system, just as the bite of a cobra does, they are in the minority; the great bulk of cases are not of this character at all, but are purely local, and if we can help the peritoneum temporarily by drainage, we can secure a triumph.[1]

---

[1] A. Caillè. [2] E. Ziegler. [3] L. Tait.

Since the practice of opening the abdominal cavity in peritonitis has been adopted by some surgeons, local sources of disease have been found, before quite unknown and unsuspected, which were removable, and prompt recovery has followed.

The following case is given in illustration of the importance of abdominal section in chronic peritonitis: Woman, æt. 18, greatly emaciated, temperature about 102°, pulse about 120; chief symptoms vomiting and diarrhœa; abdomen distended with fluid. On section of walls three pints of purulent fluid escaped, and a quantity of white flocculent clots; emptied and cleansed cavity, and introduced drain tube; continued to drain one week; on removal of stitches wound opened completely and large masses of white purulent clot were extracted, wound healed in two months, and she recovered excellent health.[1]

It may be submitted as a conclusion from these facts and recent experiences, that the most rational treatment of peritonitis, especially of the graver forms, is by abdominal section. The primary object should be the removal of all accumulations, cleansing, disinfection, and drainage of the cavity, and the secondary purpose should be exploration with a view to remove accessible sources of disease. Operate as follows: Make an incision in the median line three inches in length below the umbilicus, and open the peritoneal cavity. Evacuate the contents, and carefully explore all parts accessible; wash out the cavity with warm water. If necessary, an aseptic sponge on a holder may be used to remove the collection in parts of the cavity from which it does not readily escape. A weak solution of carbolic acid, 1–100, or of bichloride, 1–10,000, may be used first, and ordinary warm water to cleanse the cavity finally. Drainage tubes should be introduced into the deepest recesses, and the wound closed with antiseptic dressings. The cavity may be repeatedly washed out if the conditions and symptoms demand such cleansing. If an abscess or ruptured viscera, or other cause of the peritonitis is found it should be remedied, but the viscera should be disturbed as little as possible.

(*b*) **Peritoneal abscesses**[2] may occur at any age, in any part of the peritoneal cavity; they are often multiple, and more frequent in the right and left hypochondria, and between the liver and diaphragm, and between the spleen and stomach and diaphragm. The diagnosis is generally obscure, and the decision must be based on the history of the case, viz., an attack of peritonitis followed by circumscribed swelling which gradually enlarges, with tenderness, and, if it is so located that it can be examined with the fingers, indistinct fluctuation. Exploration by the aspirating needle will alone definitely determine the nature of the swelling. If pus is found, an incision must be made over it, the abscess exposed and opened, the cavity cleansed and disinfected, a drain introduced, and iodoform dressings applied.

---

[1] L. Tait.

H. Morris.

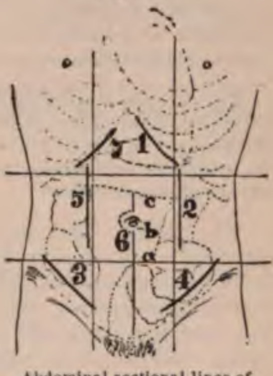
IV. GENERAL OPERATIONS ON THE ABDOMEN.

Abdominal section,[1] laparotomy, is now an operation of very frequent performance in the treatment of injuries and many of the diseases of the abdominal viscera. With proper precautions the simple incision of the abdomen has proved to be a very harmless measure. Its fatality is due chiefly to the complications which exist, such as hemorrhage from previously inflicted wounds, gangrenous intestines, fecal extravasation. These complications are largely due to delay in the operation, and hence it should be performed at the earliest practical period.

The operation is usually regarded as a last resource; it should be the first resource, especially as it is certainly the only resource; in cases of doubt, all recent experience in abdominal surgery would speak in favor of an exploratory incision; a simple cut into the peritoneal cavity, made with proper caution, cannot be so calamitous a circumstance as an unreduced strangulation, or even as a case of intestinal obstruction treated absolutely in the dark.[2]

Though the incision may be made in any part of the abdomen (Fig. 480), yet in by far the larger number of cases the median section, 6, is to be preferred, for through this wound all parts of the cavity can be explored; the incision is simple as no important structures are involved, no vessels of any size are divided, the wound is not deep, and after the operation its edges can be easily approximated. Through this incision the most varied forms of intussusception have been reduced, and enterotomy and enterectomy have been performed. Even in obstruction after the reduction of a hernia it is better, as a rule, to make the median incision. Finally, this method does not prevent other operations, as colotomy, and if merely exploratory inflicts the least serious injury.

Fig. 480.



Abdominal sectional lines of incision.

If the incision be made over the supposed seat of obstruction it is probable that the abdominal muscles will have to be cut through, important planes of connective tissue will thus have to be opened up; vessels that may cause troublesome bleeding are apt to be divided; the wound will be deep, and must be relatively larger than the median to obtain an equally extensive display of the interior of the belly; muscular wounds are not easy to adjust, and in the abdomen are likely to lead to hernia, and finally an error in diagnosis is likely to involve the necessity of another serious operation.[1]

Provide as follows for the abdominal section and the closure and dressing of the wound; additional instruments and materials being selected according to the necessities of each case: A scalpel, a director, dissecting forceps and several catch forceps, aseptic sponges on holders and several large, flat sponges; aseptic catgut ligature, silver wire; prepared silkworm-gut thread for suture; irrigator filled with 1–2000 bichloride solution and washbowlful of 1–5000 bichloride solution for sponges; trays with carbolic solution for instruments; iodoform; bichloride gauze and bichloride cotton; broad gauze bandage; binder and safety pins. The air of the room should be pure, moistened with carbolic spray, and about 80° of temperature. The operator and assistants must thoroughly cleanse their hands and nails with soap, water, brush, and bichloride solution. The rubber sheets should be arranged so as to drain away the water into a pail. The abdomen of the patient must be cleansed, disinfected, and shaved. Towels wrung out of the bichloride solution must be spread all around the vicinity of the proposed wound, and the instruments placed in a carbolic acid solution. Irrigation should be continued until the peritoneum is opened, when it should cease. The bladder having been emptied, make an incision along the median line from the umbilicus, towards the pubes, sufficiently long to admit the entire hand. On exposing the peritoneum, ligate any bleeding vessel, then pick up a fold with the forceps or fingers, and incise it with the point of the knife; introduce two fingers or the director, and enlarge the opening to the full extent of the wound. The protrusion of the bowels must be carefully prevented by applying the large flat sponges, wrung out of the hot sublimate or carbolic solution, and forcing them gently upwards and away from the wound; the sponges should be changed before they become cool.

---

[1] J. Ashhurst, Jr.

[2] F. Treves.

The practice of allowing the bowels to escape for the purpose of more readily feeling the obstruction is absolutely bad; some surgeons appear to have used flannels wrung out in hot water, but a more unsuitable material could hardly be imagined, as the hairy particles of the flannel adhere to the intestines with the greatest readiness.[1]

The closure and dressing of the wound vary with experienced operators. As a rule, the peritoneal wound should be so closed with a continuous catgut suture as to bring the serous surfaces well in contact throughout, one of the flat sponges being interposed between the intestines and the wound in order to prevent the former from being injured; this must be carefully withdrawn from the cavity before the last sutures are taken. The next sutures should be of two kinds; the first are designed to relax the margins of the skin wound, as in fleshy persons, and are taken at intervals deeply, not including the peritoneum; and the other is to bring the margins into accurate apposition. The first may be of wire, or prepared Chinese or worm-gut silk, and the latter of catgut. The former may be fastened by twisting, or by a knot, or by the button suture; the latter should be the continuous suture. If there is no marked strain on the sutures, the surface should be dusted with iodoform, several thicknesses of iodoform gauze applied, then a broad layer of borated or carbolized cotton, the whole being supported by a broad bandage passed several times around the body. If there is great tension upon the sutures broad rubber adhesive strips, first immersed in the bichloride solution, may be applied. If a drain is used insert it at the lower angle. Re-dress the wound in a week or ten days.

---

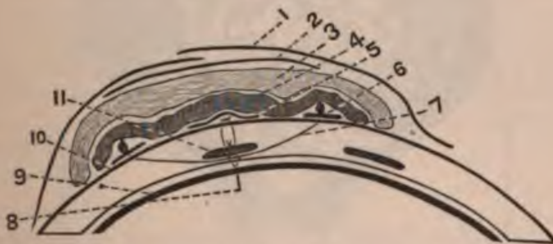
[1] F. Treves.

Although many patients recover when antiseptic dressings are carelessly applied, yet every operator will in the course of time find ample reward, and much satisfaction, if he complete this part of the operation with the greatest care and painstaking. A more elaborate dressing is as follows:—[1]

Pass strands of silkworm-gut transversely across the wound at distances of an inch and a half apart; each strand passes through the tissues above peritoneum and below muscle, and emerges from the skin at points situated two or three inches from either margin of the wound. These strands are to support the abdominal walls; and when the proper time comes they are to be fastened as follows: Take from the carbolic-acid solution two strips of sheet-lead; each strip is an inch or more in breadth, and is nearly as long as the wound; holes have been made through the long middle of the strips with an awl at distances of half an inch apart; apply one strip first; pass the emerging ends of silkworm of one side of the wound through the corresponding holes in the lead; slip a perforated shot down on each gut to the lead. Pinch the shot so that it will hold; an assistant now presses on the sides of the abdomen and relaxes the region of the wound. The second strip of lead is applied to the silkworm-gut strands on the other side of the wound; after the shot have been pinched fast, the two strips of lead should support the abdominal wall near the wound so well that no tension is exerted on the catgut sutures, all strain falling on the silkworm-gut instead; the proper time for applying and fastening the lead strips is after all other suturing has been completed. The other suturing should be done as follows:—

Unite the cut margins of peritoneum with a row of interrupted catgut sutures placed half an inch apart; irrigate; bring the muscular or fibrous margins together with a row of interrupted sutures of chromic catgut placed rather more than half an inch apart; be sure that each knot is a square one, and that the ends of catgut are not cut too short. Irrigate. Suture the skin and adipose tissues with a row of interrupted catgut sutures placed more than an inch apart, and then put in a continued suture for close approximation of skin margins. Drainage apparatus is not ordinarily required for this wound. After tightening

Fig. 481.



Theoretical transverse section through abdominal wall and dressing. 1. Binder. 2. Gutta-percha tissue. 3. Bichloride cotton. 4. Bichloride gauze. 5. Lister protective. 6. Lead plate and shot. 7. Silkworm-gut sutures. 8. Catgut suture. 9. Peritoneum. 10. Abdominal wall. 11. Rectus muscle.

---

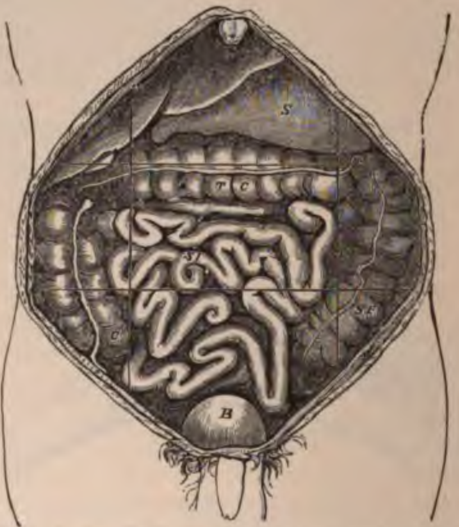
[1] R. T. Morris.

the silkworm-gut sutures, iodoform is to be sprinkled over the abdominal wound and under the lead strips. The gutta-percha tissue, towels, rubber sheet, etc., may now be removed. A two-inch wide strip of Lister's protective is laid over the line of catgut sutures; put a handful of mussed-up gauze over the protective and the lead; a wad of bichloride cotton two inches thick covers the gauze; the wad must be large enough to extend two or three inches beyond the margins of the gauze on all sides. Cover the cotton with a foot square piece of gutta-percha tissue, so that the dressing will remain slightly moist for a few days. Pass a broad bandage around the abdomen. Pin a binder snugly over all. Remove the gutta-percha tissue covering at the end of six or seven days. Change the dressing for the first time at the end of two weeks. Remove the lead strips and the silkworm-gut. Apply a handful of bichloride cotton and allow it to remain for a couple of days—until the little silkworm-gut tracks have closed.

V. RELATION OF THE VISCERA OF THE ABDOMEN TO ITS WALLS.

The abdomen is divided into regions by imaginary lines drawn as follows: vertically from the eighth costal cartilage to the middle of Poupart's ligament on each side, and horizontally at the level of the ninth costal cartilage and the crest of the ilium respectively (Fig. 482).

Fig. 482.



The abdominal viscera *in situ*, the great omentum having been removed in order to show the parts more distinctly. The lines mark the regions of the abdomen. *L.* Liver (left lobe). *S.* Stomach. *S. I.* Small intestine. *C.* Cæcum. *T. C.* Transverse colon. *S. F.* Sigmoid flexure. *B.* Bladder (distended).[1]

The names of the several divisions into which these lines divide the abdominal cavity, and the organs which in health are found in them are conveniently presented in the following form:—

---

[1] C. Heath.

Right Hypochondriac Region. Right lobe of liver and gall-bladder, 1st part of duodenum, hepatic flexure of colon, right supra-renal capsule, and part of right kidney.	*Epigastric Region.* Stomach (centre and pylorus), left lobe of liver, cœliac axis, abdominal aorta, vena cava, semilunar ganglia, receptaculum chyli, and vena azygos.	*Left Hypochondriac Region.* Stomach (cardiac end), spleen and tail of pancreas, splenic flexure of colon, left supra-renal capsule, and part of left kidney.
Right Lumbar Region. Ascending colon, small intestine, 2d part of duodenum, head of pancreas, right kidney.	*Umbilical Region.* Great omentum, transverse colon, 3d portion of duodenum, body of pancreas.	*Left Lumbar Region.* Descending colon, small intestine, left kidney.
Right Iliac Region. Cæcum coli, ureter, spermatic vessels.	*Hypogastric Region.* Small intestines, apex of bladder in distension and in children. Pregnant uterus.	*Left Iliac Region.* Sigmoid colon, ureter, spermatic vessels.

CHAPTER XL.

THE STOMACH.

THE stomach is placed immediately behind the anterior wall of the abdomen, below the liver and the diaphragm, and above the transverse colon; when moderately full its transverse diameter is about twelve inches, its vertical diameter about four; when empty it occupies only a small part of the left hypochondriac region, the spleen lying behind it, the left lobe of the liver in front, and the under surface of the heart rests upon it above. The stomach is divided by constrictions into the right and left pouch and central portion.

I. THE CARDIA.

The œsophagus terminates at the cardiac orifice of the stomach two or three inches from the great extremity, which projects beyond the place of union, forming the great cul-de-sac, or fundus. The orifice lies to the left of the middle line of the abdomen, just below the junction of the seventh costal cartilage with the sternum.

Stricture of the cardiac orifice of the stomach may be due to the same cause as stricture of the œsophagus, viz., injury, or cancer. The diagnosis of these affections is not difficult. Knowledge of the accident always reveals the nature of the first class, and a discrimination of the symptoms leads by exclusion to a correct diagnosis of the latter affections. Operative procedures have been attempted, and have proved successful in relieving only the cicatricial stricture. Dilatation of such a stricture through the œsophagus having failed, the following operation was performed:—[1]

An incision about fifteen centimetres (five inches) long was made through the abdominal wall from the xiphoid cartilage downwards and somewhat to the left, to the aponeurosis of the rectus muscle; the hemorrhage was arrested and then the peritoneum was opened; the stomach was contracted and overlapped by the liver, making it difficult to expose the former; when this was done a longitudinal incision was made through its walls between the two curvatures, having its upper end as near the cardia as possible. The next step was to find the orifice of the œsophagus; the attempt was attended by vomiting, but by searching with the left index-finger between the concave surface of the liver and the small curvature of the stomach the end of the œsophagus was found. The distended stomach was kept drawn down by an assistant while the operator introduced the dilator, guided by his forefinger into the cardiac orifice, from whence it easily passed the stricture. The dilator measured about eight inches from the joint to the ends of the blades, and was so set that the blades would not separate more than five centimetres; with the blades dilated to this extent the instrument was run up and down the œsophagus four times. The patient entirely recovered; on the fourth day there was a disturbance of circulation and respiration, which soon subsided.

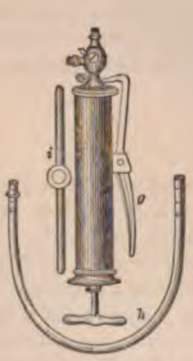
The following conclusions are submitted:[1] (*a*) Instrumental dilatation of the œsophagus through a wound in the stomach seems much preferable to gastrostomy, since the former effects a radical cure, while the latter leaves the stricture uncured, and the patient is in a hardly better condition than he was before, in consequence of the troubles connected with the gastric fistula; (*b*) operations on the stomach are of good prognosis.[2]

The operation has been six times repeated, and with complete recovery in each case.

II. THE STOMACH PROPER.

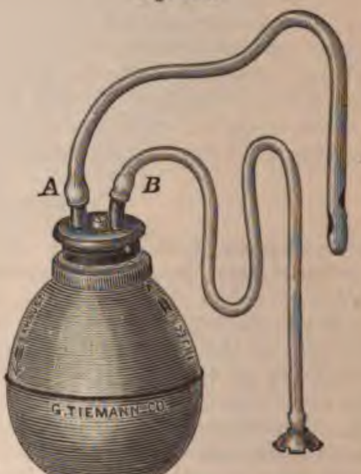
Medication by the stomach must occasionally be effected by instrumental means, as in the removal of poisons and the injection

Fig. 483.



Stomach-pump.

Fig. 484.



Bulb stomach-pump.

[1] Loreta.

[2] T. Holmes.

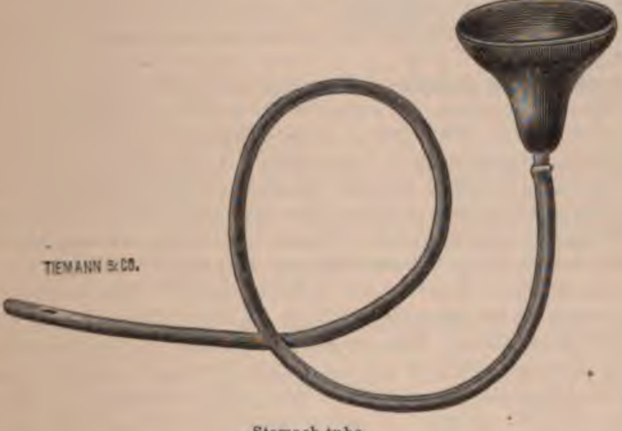
of foods and remedies. For these purposes the stomach-pump (Fig. 483) is required.

The lever *g* (Fig. 483) operates a valve causing either induction or eduction as the instrument may be required for use as a stomach-pump or enema syringe; in the former case the flexible tube, *h*, is screwed to the lower end, and in the latter to the side branch of the instrument; the mouth-piece, *i*, is held between the jaws of the patient, the tube being introduced through its central opening.

A very simple pump (Fig. 484) is now in use in which the valves change by rotating the bulb half round. This injects into or exhausts from the stomach by merely a half rotation of the bulb.

For the purpose of feeding patients, especially the insane, the stomach tube with a funnel answers an excellent purpose (Fig. 485).

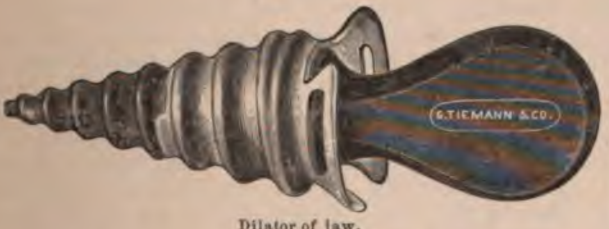
Fig. 485.



Stomach tube.

Where the patients violently resist the effort to introduce the tube, it is often difficult to open the mouth and introduce the mouth-piece, the tube may be introduced through the nose, or a mouth-gag (Fig. 486) may be employed.

Fig. 486.


G. TIEMANN & CO.

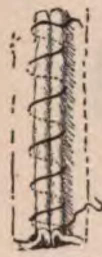
Dilator of jaw.

The light colored part on cut is a metal ring. After it has been screwed into the jaw between the teeth, the rubber part with handle, black on cut, is withdrawn leaving the ring between the teeth, through which the finger or stomach tube is passed.

The pump is used as follows: Place the patient in a chair, wi head thrown back and supported, and the mouth widely opene the tube and curve the end slightly, that it may more readily the curve of the pharynx; press down the tongue with the fing pass the curved end rapidly along the roof of the mouth into th rynx, but without touching the soft palate, which is spasmo drawn upwards; now bend the head slightly forwards to give form curve to the cervical and dorsal vertebræ, and push th gently but firmly onward to the stomach; if resistance is encour withdraw it slightly and again press it forwards; the only dar the liability of the tube to enter the larynx; if the patient is i ble, or resists the introduction, the gag *i* (Fig. 486), must be between the teeth and the tube inserted through the hole; if t is not present, a tube may be passed along the floor of the nostr the pharynx. If the tube is introduced to remove matters, as p first inject warm water each time suction is made, and in excess amount withdrawn.

Wound of the stomach is recognized by its position, its and its special direction, the escape of food or drink, vomiting of pain and faintness, with pallor, cold extremities, small and fr pulse, thirst, singultus, and tympanitis; if the organ is empty will be no extravasation, and the amount of hemorrhage will upon the extent to which the curvatures and extremities, where th ries are located, are involved. Ocular inspection, when possibl the introduction of the educated finger into the wound, give th positive evidence of these lesions of the stomach.[1] The surgeon not approach these wounds without having taken every nec antiseptic precaution. The proper treatment is careful closu suture. Gastrorraphy, or suture of the stomach, should be formed as to secure the inversion and approximation of the surfaces. If the wound is a mere puncture, pinch up the lips opening and include it in a ligature; in small wounds, whateve direction, make the interrupted suture with a fine cambric need armed with a small but strong and well-waxed thread; pass the from one side of the wound to the other, across all the tunics bowel except the mucous, in such a manner as to bring the edges in the most accurate apposition; place the s about two lines apart, and introduce the entire n before any are tied (Fig. 489); secure the ends wit ble knots, and cut off close; as the sutures become so they will disappear in the cavity of the peritoneum; the wound is of unusual length select the continued (Fig. 487); each stitch including not more than half of substance; the ends of the thread being well secu each angle of the opening should be cut close to t face of the tube. Accessible shot wounds of the a wall should be treated by suture, but the bruised should not be refreshed, for as the loss of substa confined to the muscular, connective, and mucous the serous membrane remains sufficiently organi

Fig. 487.



Continuous suture.

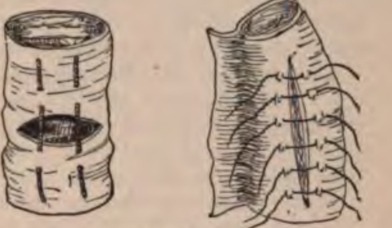
---

[1] G. A. Otis.

hold stitches; what sloughing there may be from the inner tunics will fall into the cavity of the stomach; cut the ends of the sutures short, and return the whole within the cavity of the abdomen.[1]

Take a short stitch on one side of the wound, about two lines and a half from the edge, including only the peritoneal and muscular coats, then carry the needle across the gap and take a similar stitch on the opposite side; repeat the stitches, the interval not exceeding the sixth of an inch; when they are all arranged, draw them firmly together, tie with a double knot and cut off the ends; the wound is thus completely closed in every portion of its extent; its lips being inverted their serous surfaces approximate[2] (Figs. 488, 489). Or, arm a waxed thread at either end with a small glover's needle; introduce one parallel to the wound without and back of one of its angles about one line, and bring it out on the peritoneal surface after traversing the bowel for about the sixth of an inch; practise the same upon the opposite side with the second needle; cross the threads, and pass the right needle through the puncture made by the left, and conversely; repeat the stitch as often as may be necessary to completely close the wound; tighten the threads by taking each successively at the transverse points with dissecting forceps, and make suitable traction, at the same time depressing the lips of the wound; tie the threads, and cut them close; the approximation is so complete that no trace of the threads or knot appear externally.[3]

Fig. 488. Fig. 489.



Lembert's suture.

The after-treatment consists in administering, for a few days, ice in quantities to allay thirst and quiet irritability; after that a little arrowroot, tapioca, sago; if gastrorraphy has been neglected, or is impracticable, withhold everything by the mouth until the edges of the wound have contracted adhesion to the adjacent parts, and rely upon the application of ice to the epigastrium, nourishing enemata, and morphia to relieve pain.[4]

Foreign bodies are often introduced into the stomach accidentally or intentionally, and unless removed may create fatal inflammation and ulceration; they may remain in the stomach for a certain period without much inconvenience, but sooner or later they produce serious consequences; if the substance be a piece of money, or any other small body, it will be passed off, often without much discomfort, in the course of a few days, sometimes within forty-eight hours of having been swallowed; but should the substance be a bone or other irregular-shaped or uneven mass, it may be some weeks before it escapes through the rectum. The early symptoms of a foreign body in the stomach will depend very much on the shape and nature of the mass; a pin, or sharp bone, or pointed instrument, will cause pain in the epigastrium, often of a severe character, a sense of weight and discomfort at the stomach, a desire to vomit, or an ejection of the contents of the stomach with blood; if the person is thin and the substance large, it may occasionally be detected, through the abdominal walls. A sharp-pointed mass may gradually penetrate the walls of the stomach and ultimately escape externally; needles and pins may pass through various structures and make their exit at some distance from the point at which they escaped from the stomach. The treatment must depend upon the nature and shape of the substance; pieces of money and many other bodies are aided in their passage by bulky ingesta, and hence it is better to avoid purgatives, and rather allow food plentifully in order to have the foreign body embedded in and surrounded by feculent matter. If the body is retained in the stomach and life becomes endangered by its presence, the stomach should be opened and the foreign body removed. Gastrotomy, section of the stomach, for the removal of foreign bodies, has proved an entirely feasible and successful operation; the method of procedure is in detail the same as gastrostomy (p. 478), but the wound must be closed by sutures.

---

[1] G. A. Otis.
[2] M. Lembert; S. D. Gross.
[3] M. Gély.
[4] S. D. Gross.

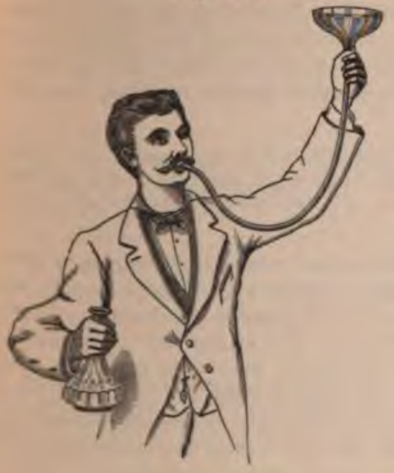
Dilatation of the stomach, gastrectasia, results more often from obstruction of the pylorus, but may be due to diseases of its coats. The diagnosis may at first be doubtful, owing to the varying size of the organ, but dilatation is known to exist when the stomach tube can be felt below the horizontal line drawn from the anterior superior spinous process on one side to that on the other. The operative measures for its relief are twofold: (*a*) Systematic washing out of its cavity, and (*b*) the removal of the pyloric obstruction. The first measure only will be considered in this connection. Whatever may be the cause of the obstruction the effect upon digestion is the same, viz., a tendency to fermentation owing to the long detention of the débris of the digestive process, which escapes from the stomach only imperfectly, and principally by vomiting. By washing out the stomach the irritating matters retained in it are removed, and the internal surface of the stomach is cleansed by water, and thereby somewhat restored to its normal condition. The water may be pure, or bicarbonate of sodium may be added; Vichy water is very useful; if there is much fermentation salicylate of sodium, 1 per cent., or resorcin, 2 per cent., may be added to a pint of water. The washing-out should be daily, half an hour before the principal meal. The simplest apparatus is the flexible siphon tube (Fig. 490) thirty inches long, with a funnel. The patient may be taught to use the tube. It is to be first placed in warm water, and the patient takes a mouthful; now introduce it into the pharynx, and gently push it downwards while the patient makes efforts to swallow, thus carrying the tube along the œsophagus.[1] When the tube reaches the stomach the contents will escape; a pint of tepid fluid should now be allowed to flow in, the funnel being raised above the head (Fig. 490); then the funnel should be lowered (Fig. 491) and the contents of the stomach siphoned out. This process should be repeated several times at one sitting.

The siphon has unquestionably the disadvantage that it can withdraw from the stomach only fluids, or at least only substances which are very nearly fluid, so that one is obliged finally to resort to the pump to remove the remnants of the ingesta; in the treatment of gastrectasia, the removal of the ingesta to the fullest extent possible is altogether the most important indication, and therefore, that instrument is to be prefered by which the result can be most certainly attained. The operation of washing out the stomach when intrusted to the patient alone, without the supervision of the physician, is attended with so much risk from the unavoidably awkward movements of the patient, that the

---

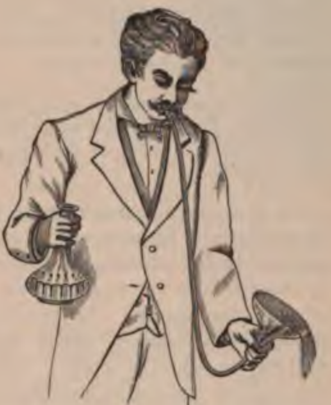
[1] W. B. Platt.

Fig. 490.



Filling the stomach.

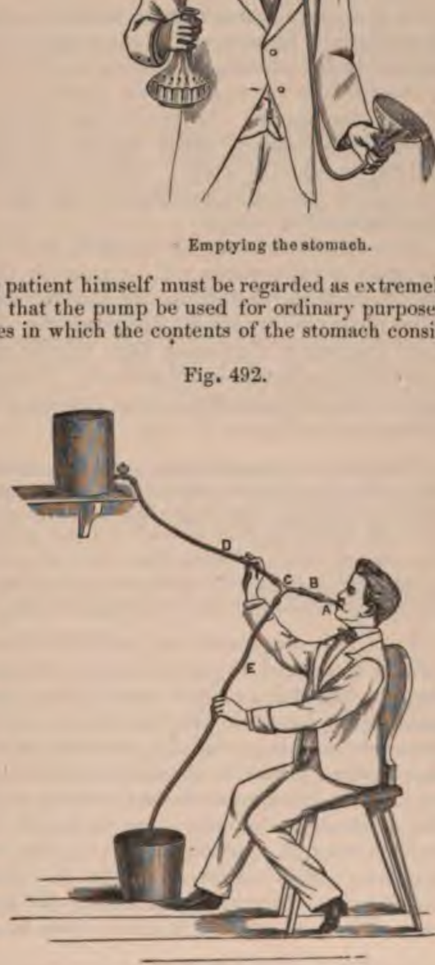
Fig. 491.



Emptying the stomach.

relegation of the operation to the patient himself must be regarded as extremely hazardous. It is recommended that the pump be used for ordinary purposes, and the siphon only in those cases in which the contents of the stomach consist entirely of fluid, or in which a complete evacuation is unnecessary.[1]

Fig. 492.



Compound syphon.

Another form of siphon highly recommended[1] (Fig. 492) will be readily understood by the illustration. The stomach tube, A, is connected by a stout piece of rubber tubing with one limb of a glass triangle, C, the two other limbs being attached to long rubber tubes; one of these, D, passes to the stop-cock of an irrigator, the other, *e*, into a receiving vessel; the water is first allowed to flow from the receiver into the stomach by turning the stop-cock and compressing the tube E; when the water reaches the stomach the pressure is removed from E, and the contents of the stomach flow into the receiving vessel; by compressing D the contents of the stomach escape; by relieving D water again flows into the stomach, and may again be removed by compressing that tube.

---

[1] W. O. Leube.

Gastrostomy, the formation of a fistula of the stomach, has been performed when death was imminent from inanition depending upon closure of the œsophagus, as from cancer, cicatrices from swallowing caustic matters, syphilis. The method of accomplishing the object is by the formation of a fistulous passage through the walls of the stomach and of the abdomen.

Of 167 operations for malignant disease 135 died, or 80.8 per cent.; of 37 operations for cicatricial contractions 21 died, or 56 per cent.; of 3 miscellaneous cases 2 died, or 66.6 per cent.; of 43 additional cases 27 died, or 62 per cent.[1]

It is apparent from these statistics that gastrostomy for the relief of malignant disease of the œsophagus should not be encouraged, nor should it be performed except in special instances where the conditions render the operation a necessity. For cicatricial contractions of the œsophagus, the result is sufficiently favorable to make the operation justifiable, other means of relief having failed. It is advisable to operate early;[2] this is especially true since the introduction of the antiseptic method, for the danger of intervening peritonitis is comparatively slight.

The operation[3] may be divided into three stages, viz: 1, to open the abdominal parietes; 2, to transfix the stomach and secure it to the edges of the wound in the abdomen, and to the integument; and, 3, to open the stomach; between the second and third stages it is most important that some days should elapse; the strictest antiseptic precautions should be observed. Proceed as follows: Having administered an anæsthetic, map out by percussion the situation of the stomach.

The area of stomach residence varies somewhat in different individuals, and also in the same person according to the viscus itself. In those who have been suffering for some time from partial starvation, the organ is apt to be retracted so as to be altogether covered by the inferior margin of the thorax. To obviate any difficulty from this source the stomach has been successfully inflated with air before the operation; ether has been pumped into it; also gas has been generated by administering the proper chemical ingredients.

1. In this stage make an incision through the skin for a distance of two or three inches parallel to the left costal margin and about one finger's breadth to their inner side; the centre falling about three-quarters of an inch internal to the outer edge of the rectus. Hold asunder the lips of the skin-wound and divide the fibres of the rectus in a vertical direction for about an inch, all hemorrhage being checked by torsion of the vessels, or ligatures of fine carbolized catgut; when the parietal peritoneum is reached, pick it up gently with forceps, and make a minute opening in it with the knife; introduce through this aperture a grooved director, and slit up the membrane in the axis of the incision through the rectus; the peritoneal sac being thus laid open, the stomach will in most cases be at once visible.

Sometimes, instead of it, the omentum or even the colon comes into view; the former is not likely to mislead the operator, but as it has actually happened that the colon has been opened instead of the stomach, it is well to be on guard against such an accident. The longitudinal bands, together with the *appendices epiploicæ*, and the thinness of the walls will serve to identify the colon, which should be gently pushed downwards out of the way. Should the omentum present itself in the wound, gentle traction should be made until the stomach is brought down so as to bulge out somewhat like a hernia.

---

[1] S. W. Gross. [2] T. Bryant; T. R. Pooley. [3] M. Mackenzie.

2. In order now to keep the stomach in a proper position and prevent its falling back into the abdominal cavity during the remaining steps of the operation, transfix the base of the projecting portion in a direction parallel to the surface of the belly by two long needles, the extremities of which should reach considerably beyond the edges of the wound on either side; the stomach is thus held fast between two transverse supports resting on the surface of the body; now stitch the viscus to the abdominal wall either by a single or a double series of sutures.

One set of stitches may be used, the sutures, which are of silver wire, being passed first through the skin close to the edge of the wound, next through the parietal peritoneum, lastly through the peritoneal and muscular coats of the stomach, and out again; the ends are then threaded through a perforated plate, and afterwards through shot drilled with a hole for the purpose, when they are fixed by crushing the leaden ball over them with pincers.[1] Some prefer a double circle of stitches; the outer, which consists of carbolized silk sutures, passes through the serous and muscular tunics of the stomach, and afterwards through the skin about three-quarters of an inch beyond the lip of the wound, and is here tied over pieces of quill; the inner circle is made with ordinary sutures of fine wire or carbolized silk, and unites the serous coat of the viscus to the skin close to the edge of the incision. The object of the two circles of stitches is to provide a greater area for adhesion, the whole of the zone between the two circles being likely to unite with the abdominal parietes.[2]

3. In the third stage it is most important to delay till adhesions have been produced between the corresponding peritoneal surfaces round the wound, and the stomach thereby securely fixed to the abdominal wall.

Some defer the third step of the operation till the fifth or sixth day;[2] others prefer an interval of a week or even a fortnight to elapse between the preliminary part and the completion of gastrostomy.

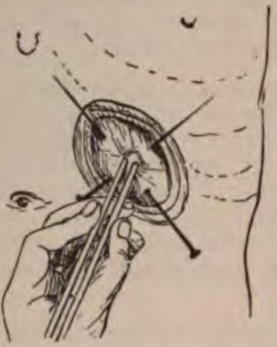
The stomach may be opened by puncturing the centre of the exposed portion with a fine-pointed bistoury. As considerable hemorrhage has followed this apparently simple proceeding on more than one occasion, the surgeon should be prepared for such a contingency, the occurrence of which is probably favored by the congested condition of this islet of stomach-wall included within the ring of sutures. Pressure will probably suffice to stop the bleeding, or the risk may be altogether avoided by opening the stomach with a thermo-cautery point. An India-rubber tube, provided with a plug, may be left in the wound, and kept *in situ* by means of a silver suture, passing through it and the skin on each side.

In the first successful case[3] the stomach had shrunk together and attached itself to the vertebral column; its front side was grasped at a point corresponding best with the incision, drawn somewhat forward out of the opening, and fixed temporarily in the opening by two acupuncture needles stuck through it transversely; the two needles rested crosswise on the outer surface of the abdomen (Fig. 493); in order that the peritoneum should with certainty be included in the sewing up, the edges of it, where cut, were grasped with pincettes and drawn forward and secured by laying the pincettes over on one side; for the stitching, moderately strong silk was used, and the stitches were so arranged that the outer skin, the wall of the abdomen, and the peritoneum were pierced, and the wall of the stomach taken up as much as possible in its entire thickness; fourteen stitches were made; after the sewing, which surrounded a piece of the stomach wall in the form of a circle about five-eighths of an inch in diameter, was completed, the stomach wall was cut through within this circle crosswise, and a drain-pipe inserted in the stomach, which was found to be perfectly empty; the whole operation was conducted under antiseptic precautions.

---

[1] L. Verneuil. [2] Howse. [3] F. Trendelenburg.

Fig. 493.



Opening stomach.

The temporary securing[1] of the front part of the stomach-wall in the incision by means of acupuncture needles stuck through crosswise and resting flat on the outside of the abdomen, is to be recommended, also the bringing forward the cut edge of the peritoneum by means of pincettes. The difficulty of finding the stomach with so small an opening in the abdomen deserves some consideration, for the mistake has been made of sewing up the colon instead of the stomach. The diaphragm and the vena gastro-epiploica, which is seen more distinctly than the artery, will always be the safest guides. It is not desirable to make the fistula larger than is absolutely necessary for the purpose of fixing a drain-pipe of about five-sixteenths of an inch; there is not much gained for the nourishment by a large opening, for in the normal method of feeding through the œsophagus the food does not reach the stomach in unbroken bites, but in a state of coarse pulp, and the attempt to surpass nature in this respect cannot be conducive of very beneficial results. Apart from this, a large opening has great disadvantages. It necessitates having a special apparatus for closing the entrance, where, as with a small fistula, it is only necessary to put in a suitable drain-pipe and cork it up from the outside, to close the stomach entirely. This kind of stopping is perfectly water-tight,[2] because the somewhat swollen mucous membrane of the stomach sets itself close against the drain-pipe.

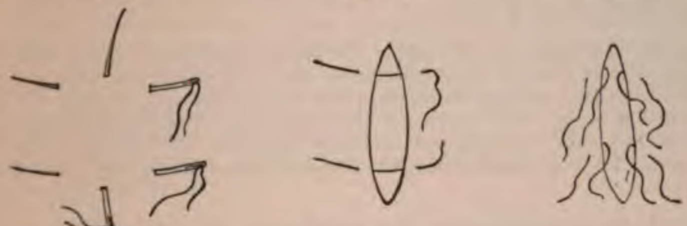
Another method is to seize the stomach with forceps having fine strong teeth, and pass a curved needle, armed with strong silver wire, through its anterior wall in the direction of the vertical line of the body, the points of entry and exit of the needle being about an inch and a quarter apart; now pass two other needles armed in the same manner from left to right, and make them cross the first at right angles (Fig. 494); the wires thus include the part to be opened, which will be at a point about two inches to the left of the pylorus; withdraw the first wire, and with scissors open the stomach in a perpendicular direction to the extent of an inch, exposing the wires (Fig. 495); divide them and convert the wires into sutures (Fig. 496); after the stomach is opened, make constant traction upon it to prevent the escape of its contents into the abdominal cavity; now attach by numerous silver sutures the edges of the viscus to the opening in the abdominal walls so as to secure the most accurate approximation; introduce a tube with a single flange, resting upon the edges of the external wound, and confined by means of tapes passed around the body; close the remaining wound in the abdominal parietes by ordinary sutures.

---

[1] L. Verneuil.

[2] F. Trendelenburg.

Fig. 494. Fig. 495. Fig. 496.



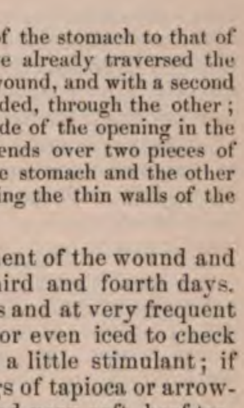
·Suture of stomach wound.

The quill suture has been used to unite the wound of the stomach to that of the skin; to do this, first pass the needles that have already traversed the stomach, and are still armed, through one side of the wound, and with a second needle draw the free ends of the ligature, when threaded, through the other; there will then be two double ligatures through each side of the opening in the stomach and the margin of the wound; tie the two ends over two pieces of bougie, one introduced against the inner surface of the stomach and the other upon the integument, the bougies admirably compressing the thin walls of the integuments and retaining them there.

The after-treatment requires careful management of the wound and diet. The stitches may be removed on the third and fourth days. Nourishment should be given in small quantities and at very frequent intervals, and during the first it should be cold or even iced to check vomiting; at first give only milk, beef-tea, and a little stimulant; if the stomach begins to act well add light puddings of tapioca or arrowroot, hot milk sweetened with sugar, eggs boiled very soft, beef-tea, chicken broth; when digestion is established add pounded meat or panada.

In a successful case feeding was in imitation of the natural mode of taking food, nourishment being given in small spoonfuls at intervals of half a minute. Or the final arrangement for taking food may be through a long tube fastened to a drain-pipe in the fistula (Fig. 497). In this case, the œsophagus is removed to the outside, otherwise the process is as much as possible like the natural one; the boy tastes his food as before; the masticated and salivated matter remains partly in his mouth and is partly swallowed down into the œsophagus, after which he places the tube in his mouth, and sends the food by a slight choking and spitting motion into the tube, and lets it glide down into the stomach, assisting it by blowing slightly with the mouth; then he shuts the pinch-cock, which he had previously opened, and recommences the process afresh. In this manner he is made independent; he runs and jumps almost the whole day with the drain-pipe in the fistula without a trace of the contents of the stomach flowing out; the neighborhood of the fistula remains dry.

Fig. 497.



Supplying masticated food to stomach.

Excision of portions of the stomach have been made for cancerous affections of that organ. Excisions of the pyloric portion have been performed as a part of the operations upon the pylorus, and will be noticed in that connection. An excision of the cardiac portion was performed, as follows:—[1]

The incision was in the linea alba; the gastric artery was first tied with ease, but the splenic, from its deeper situation and close connection with the pancreas, was ligated with more difficulty, and was facilitated by raising the pancreas with a hook. That portion of the stomach involved was removed, being about three inches long and over one inch in width. But two ligatures were required. The opening was closed by the interrupted suture; the patient lived two days.

Gastro-enterostomy, the attachment of the intestine to the stomach so that their cavities communicate,[2] has been performed to relieve the conditions due to such extensive cancerous disease of the pyloric portion of the stomach as to render excision impossible. When completed the food introduced into the stomach would pass directly into the small intestine The preliminary steps of the operation are those for gastrotomy; when the stomach has been exposed an opening is made into the viscus in the middle of the great curvature, and a corresponding opening into the small intestine, as high as possible, and the two wounds are united by the double suture so as to insure union of the opposed tissues, and leave the communication between them free.

The mortality[3] following this operation is much less than after pylorectomy. In 16 cases of malignant disease of the stomach, 10 died soon after the operation; 1 died four weeks after from the effects of secondary tumors, and 5 lived several months. As regards stricture from cancer, it may justly be claimed that it is questionable if the best results that can be obtained by it, viz., a few weeks or months of alleviation, will compensate for the immediate risks of life incident to the procedure.[3] The question is quite different in the case of non-malignant stricture.

The results obtained[3] in this cicatricial stricture are indeed encouraging. Of four cases, three recovered. In one case,[4] a man 20 years of age, the diagnosis was made of *ulcus pylori* with cicatricial stenosis; when the abdomen was opened the stomach was found enormously dilated; nothing further was done; the abdominal incision was closed; as the sufferings of the patient continued he begged that another operation be performed; the abdomen was opened again and a communication between the stomach and duodenum was established, and at the time the case was reported the patient was doing well.

The exclusion of a short space of intestine from the digestive tract by the establishment of a new pylorus by gastro-enterostomy will not interfere with the proper maintenance of health, hence the operation in these cases must be looked upon not only as a palliative but also as a curative measure. From the results already obtained it must be conceded that gastro-enterostomy should be recognized as an established and legitimate operation in the treatment of non-malignant pyloric stenosis.[3] It is important to distinguish between malignant and non-malignant stenosis before any operation is attempted. The symptoms must be carefully studied and the vomited matters analyzed. The following suggestions are useful:—

---

[1] C. L. Lane. [2] A. Wölfler; L. Billroth. [3] N. Senn. [4] Rydygier.

> In determining whether the dilatation of the stomach is due to mechanical causes or to profound structural lesions,[1] much value is to be attached to the chemical and microscopical examination of the contents of the stomach; in the simple mechanical obstacle, the coats of the stomach being uninjured, gastric digestion goes on, and the patient wastes more slowly, and even when most emaciated does not present the aspect of real cachexia; nor does the presence of food in the stomach cause pain or colic, or intestinal catarrh, all of which symptoms arise in cases of the other kind from bad digestion of the aliment as it passes into the bowels.

III. THE PYLORUS.

The pylorus is liable to contraction from cicatricial formations, and from cancerous growths. Both forms of obstruction have been subjected to operation, the former by dilatation and excision, and the latter by excision.

Dilatation of the pylorus[1] has been successfully performed in several cases, and is regarded as a proper substitute for excision in non-malignant contractions. As it is designed to relieve the stomach of the disturbances to which that organ is subjected by the stenosis of the pylorus, it must be considered how far the systematic washing out of the stomach, as already described, may be regarded as a substitute for this operation. It is certain that the washing out of the stomach is a harmless operation which gives great relief when regularly and systemetically performed, and that dilatation of the pylorus has proved fatal in cases which would apparently have long survived and in comparative comfort had the washing-out treatment been faithfully and intelligently pursued. There are cases, however, of cicatricial contraction, which will not respond to the washing-out treatment, and in which the more heroic measure of dilatation may properly be adopted. The operation[2] has been performed as follows:—

> The stomach was first washed out with an alkaline solution. An incision was made on the right side of the median line for fifteen centimetres, about five inches, the upper and inner end being about four centimetres below the xyphoid cartilage, the lower and outer end three centimetres from the cartilage of the ninth rib. The muscles were divided and the hemorrhage stopped before the peritoneum was opened. Some difficulty was experienced here on account of the great omentum being folded upwards, thickened and adherent to the parietal peritoneum, and some care was required to detach the adhesions. The omentum was adherent to the pylorus and right half of the anterior surface of the stomach, and it was this adhesion and thickening of the omentum that formed the tumor which was felt through the abdominal wall. These adhesions having also been separated, the stomach was set free, and was then drawn out of the wound as far as necessary, and the pylorus was felt to be thickened and of a fibrous hardness. The coats of the stomach were then lifted up into a transverse fold, and a cut made through them with strong scissors midway between the two curvatures, about three centimetres from the pylorus, and it was found necessary to enlarge this cut to six centimetres on account of the

---

[1] Loreta.

[2] T. Holmes.

contraction and hypertrophy of the muscular coat. The coats of the stomach bled abundantly, and this hemorrhage was repressed by means of hæmostatic forceps of a T-shape. Then the right forefinger was introduced and the pylorus examined; it was found very hard and prominent, and its orifice appeared closed; no force that could be safely used succeeded in dilating it, till the left index finger was also introduced and employed to steady the pylorus; when this was done, the end of the right forefinger was gradually squeezed through the aperture; then the finger was used to hook down the pylorus towards the abdominal wound, a manœuvre which enabled the operator to get the left index finger also through the pylorus. But it was still exceedingly difficult to effect any separation of one finger from the other, so great was the resistance, not only of the sphincter itself, but also of the coats of the stomach and duodenum. The attempt at dilatation threw the muscular fibres into spasmodic action which quite overcame all of the force that could be exerted; three such attempts were made in vain, and then the pylorus began slowly to yield to the force employed, which was very considerable. At length a sensation was experienced showing that the tissue was so far distended that it could not obey the dilating finger further without being torn. The fingers were now kept apart more than three inches for a short time. The wounds were then closed. The patient recovered, and was entirely relieved of his former symptoms.[1]

Dilatation of the pylorus has proved fatal by hemorrhage from a rent in the strictured tissues after divulsion by means of a rectal dilator, the stricture having resisted all efforts at digital dilatation.

Excision of the pylorus, pylorectomy,[2] has been performed for stricture from cancerous formations, for simple chronic gastric ulcer, and for stenosis following perforating ulcer. It belongs to the category of those novel departures from routine practice, so common at the present time, and, though its value is undetermined, the weight of opinion being adverse to it, yet its position among the new procedures in surgery is such as to make it incumbent upon the surgeon to become practically familiar with all of its details.

It is true that the complicated anatomical relations of the pylorus, the size of the viscera divided, the unavoidable tediousness of the manipulations, and the consequent prolongation of the anæsthetic state must always cause pylorectomy to be one of the most formidable and exhausting, as well as difficult, operations. No one must undertake excision of the pylorus without being prepared for a long, tedious operation; the shortest time occupied has been one and a half hours; most cases have taken from two to three hours or more, and some have occupied at least five hours.[3]

The principal facts regarding this operation may be summarized as follows:—[3]

Before the operation is decided upon the surgeon ought to satisfy himself as to the nature of the disease and the justifiability of operating under the conditions of the case in question; the symptoms should point unmistakably to pyloric obstruction; if the disease is not malignant, there should be good grounds for believing that it will, if left alone, assume a perilous character; that the lumen of the thickened part will become less and less, and the gastric dilatation more extreme, and that ulceration and possibly perforation will ensue; if the disease is malignant, the tumor should be felt to be freely movable; jaundice, ascites, anasarca of the lower limbs, and every other indication of secondary disease should be absent; and, further, the

[1] C. McBurney.

[2] Péan; L. Billroth; A. Wölfler.

[3] H. Morris.

patient's health should not have been so far deteriorated as to render success impossible.[1]

In some instances, in which the conditions have been apparently very favorable, they have not turned out to be so when the abdomen has been laid open; the mobility of a cancerous growth of the pylorus, when examined through the parietes with the patient under chloroform, is no proof that the tumor is free from important adhesions; the chain of lymphatic glands behind the stomach, at the head of the pancreas, in the omenta and mesentery, may be extensively implicated without giving palpable evidence of disease; the rapidity too with which the glands in the neighborhood of the hepatic fissure may be involved, must make the prospect of even a successful operation very doubtful.[1]

When it has been decided that the case is one for interference, the patient is to be prepared by having the stomach well washed out, and, if the stomach has become much dilated, the washing out ought also to be repeated on the day preceding the operation. The abdominal parietes should be divided, and the peritoneal cavity opened by an incision four or five inches in length. This may be made in one of three ways: (1) Parallel to the right costal margin;[2] (2) transversely over the most prominent part of the tumor,[3] though if this have sunk down very low in the abdomen—as when the pylorus is non-adherent and weighty it will do, even reaching the level of the symphysis pubis—the tumor must be raised before the incision is made over it; (3) longitudinally, in the linea alba,[4] or a little to the right of it.[5] Sometimes the transverse and longitudinal incisions have been combined before the growth has become accessible,[6] nearly the whole of the lesser curvature being infiltrated.

The transvere incision was five inches long and about one inch above the umbilicus, while the longitudinal incision was made upwards from the transverse, along the median line to the xiphoid cartilage.

Before the peritoneum is incised, all the bleeding points should be secured by torsion or ligature. In the transverse and oblique incisions the hemorrhage from the parietes may be somewhat excessive, and eight to twelve vessels may require to be controlled. The relation of the disease to the surrounding parts is to be made out as soon as the peritoneum is opened, and this is to be done either by introducing the fingers and feeling round the mass, or by withdrawing the mass, when possible, through the external wound. If the growth has invaded, or is adherent to the pancreas, liver, or transverse colon; if the lymphatic glands in the neighborhood are widely involved; or if the cancer extends to the second portion of the duodenum; or over the whole or greater part of one of the curvatures of the stomach, the operation should be at once abandoned, and the parietal wound should be closed. If the abdominal walls are invaded by the disease, the operation may be completed, though with difficulty. If the operation is continued, the next step is to detach the stomach from the greater and lesser omenta, and for this purpose the stomach is drawn up into the wound, and its walls carefully examined to ascertain at what point they should be cut through. The division of the omenta should be made step by step, between two pairs of pressure-forceps, ligaturing the cut ends before removing the forceps; or double ligatures may be passed with an aneurism needle at short intervals through the portions of the omenta to be divided, and the section made after the ligatures are tightened. Sometimes the thermo-cautery has been employed to divide these structures, but there is no advantage in its use. If any glands are infiltrated, they should be removed at this stage. As soon as the diseased parts have been isolated, a large and properly anti-septicized flat sponge should be placed beneath them, so as to protect the peritoneal cavity, and form a bed upon which these parts may lie whilst they are being cut away. The walls of the stomach are now to be cut through with the scissors, commencing with the lesser curvature and making the division obliquely across its surfaces. All the bleeding is to be arrested after each stroke of the scissors, and for this purpose many ligatures have been found necessary for the cut edges of duodenum and stomach.

---

[1] H. Morris. [2] A. Wölfler. [3] L. Billroth; A. Wölfler.
[4] Péan. [5] Rydygier. [6] C. Max Richter.

If the stomach is not quite empty, its contents should be soaked up with a sponge especially reserved for the purpose. It is held[1] that it is not necessary, after section of the stomach, to close it with the compressor, because if care has been taken to wash out the stomach well before the operation, no escape of contents need be feared. The compressors have been placed[2] on the stomach and duodenum, and then the tumor removed by dividing the intestinal walls near to the compressors.

The pylorus, now held by volsella-forceps, is next to be separated from the duodenum, which should be snipped through stage by stage in the same careful, gradual manner as the stomach, arresting the bleeding as it occurs. Lest the gut should slip back into the abdomen, a loop of silk should be passed through its serous and muscular coats, below the point of section, and it should be thus gently held by an assistant. A plug of carbolized cotton-wool, or a small sponge may be temporarily inserted into the open orifice of the duodenum.

With a view of diminishing as far as possible the inequalities in the size ot the openings of the stomach and duodenum, the enlargement of the duodenal orifice is advised[3] by making an oblique, instead of a transverse, incision across it. On the other hand it is proposed[2] to diminish the size of the gastric orifice by cutting out a triangular piece in the greater curvature, and sewing together the edges of the notch thus made. Another operation closes[4] the gastric opening till it is of the same size as the duodenal. In a case of successful pylorectomy for gastric ulcer,[5] the opening into the stomach was so small that only one finger could be inserted, and it actually had to be enlarged to make it fit the duodenal opening. This is a condition worth remembering when operating for simple ulceration or cicatrix.

The diseased mass having been excised—or it may be, even before its separation from the stomach is completed—the cut edges of the stomach in part of the length of the wound should be brought together by sutures, care being taken that the serous coats are applied to one another. In attaching the duodenum to the rest of the edges of the wound in the stomach, it is best to begin at the posterior walls. After permanently adjusting the posterior portions, the anterior parts of the stomach and duodenum are to be reunited. The serous surface of the stomach must be retained throughout against the serous coat of the duodenum. One operator[1] recommends inserting the posterior sutures from the inner surface before the duodenum is completely divided; or several threads may be carried through the walls of the stomach and duodenum to form the posterior ring suture, and should be held by an assistant whilst the separation of the growth is completed, and the occlusion sutures are adjusted. Either Lembert's or the continuous suture, interrupted and finished off after every four or five stitches,[2] should be employed.

---

[1] Mickulicz.
[2] Rydygier.
[3] Wehr.
[4] L. Billroth.
[5] Van Kleef.

Great importance is attached[3] to the manner of placing sutures. Before closing the abdomen it is well to examine each suture to see that it is fast.[1] Fine silk, such as the Chinese twist, is a good material for the sutures;[4] or carbolized silk,[5] or catgut may be used. The number of sutures required is generally very large, from forty to sixty having often been used; when the opening in the stomach is very small fewer sutures will be required. In two cases, one of which was successful, the operator[1] stitched the duodenum to the lesser curvature and closed the gastric orifice by transverse sutures. This operator thinks that there is less traction on the stomach, and a more direct passage from the stomach to the duodenum if the gut is fixed to the greater curvature. This plan he adopted in his third case.

The wound in the parietes should be closed by interrupted sutures passed through all the layers of the walls, including the peritoneum. Boracic charpie, salicylic wool, or absorbent cotton-wool, should be bandaged on the front of the abdomen and the patient placed in bed upon the back with the knees raised. For the first twenty-four or thirty-six hours, or longer, if possible, the strength of the patient should be sustained by nutritive enemata given every four or six hours. Each enema should consist of two ounces of strong beef-tea, half an egg, and a drachm of brandy, with a little opium, if required. The mouth may be moistened from time to time with a teaspoonful of iced water or fresh milk. After the first twenty-four hours the patient may commence to take fluid nourishment in small and frequently repeated doses, and by degrees a light solid diet may be permitted if all goes well.

One[6] patient ate beefsteak on the tenth day; another[7] patient took meat on the fifth day, and was up on the twentieth.

Shock and collapse have been the most frequent cause of death from the operation; hemorrhage, especially when secondary, is a source of great danger; peritonitis has not been a frequent complication. The greatest difficulty in the operation is in managing the adhesions which exist in a majority of cases, but differ widely in their location and extent.

---

[1] L. Billroth.
[2] G. Pollock.
[3] Wehr; L. Billroth.
[4] L. Billroth; Czerny.
[5] Rydygier.
[6] Van Kleef.
[7] Czerny.

CHAPTER XLI.

THE DUODENUM; THE JEJUNUM; THE ILEUM.

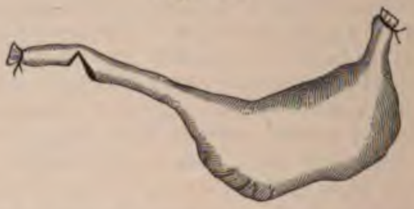
I. THE DUODENUM.

This is the shortest and widest part of the small intestine, varying in diameter between an inch and a half and two inches, and is ten to twelve inches in length.

It has no mesentery, and is only partially covered by the peritoneum; in its course it describes a single large curve, the convexity towards the right and the concavity embracing the head of the pancreas, and passing from the pylorus to the under surface of the liver, thence downward in front of the right kidney as low as the second or third lumbar vertebra, where the bowel turns across to the left, and ascends obliquely for an inch or more.[1]

Rupture of the duodenum[2] (Fig. 498) is of rare occurrence, owing to its deep situation behind the liver and the transverse meso-colon. In a case which lived twenty-four hours after the accident there was collapse, rapid respirations, frequent pulse, vomiting, and emphysema felt behind.[3] The only treatment offering any hope of success was abdominal section, cleansing of the cavity, and suture of the bowel.[3]

Fig. 498.



Rupture of the duodenum near junction of jejunum.[3]

Foreign bodies may enter the duodenum from the stomach, or from the liver and gall-bladder. Of the former, are masses of pins, collections of hair and threads, and of husks of grains, as well as large bodies, like spoon-handles, knives. Of the latter, are biliary calculi, which, if small, pass readily through the bowel, but, if large, may enter it by ulceration, and form a permanent obstruction. The symptoms are those of gastric and hepatic derangement, until the obstruction becomes considerable; then the tumor may be perceptible; the vomiting is persistent, but never stercoraceous.

---

[1] Quain's Anatomy. [2] H. Morris. [3] F. S. Dennis.

Duodenotomy may be practised if the location of the obstruction can be diagnosticated with sufficient certainty. The peritoneal cavity should be opened by an incision over the tumor. With care the duodenum may be exposed in any part of its course, and an incision may be made upon the contained body.

Duodenostomy has been practised in stricture of the pylorus. The tube was exposed by the median incision, an opening made, and the bowel attached by sutures to the external wound.[1]

II. THE JEJUNUM AND ILEUM.

The jejunum commences on the left side of the second lumbar vertebra; it is attached and supported by the mesentery and its convolutions are in the umbilical and left iliac regions. The ileum is continuous with the jejunum, and its convolutions occupy part of the umbilical, right iliac, hypogastric, and pelvic regions, and from the latter it ascends to the right iliac fossa, where it ends in the cæcum.

Jejunostomy was performed successfully on attempting pylorectomy where the liver was so involved in the cancerous growth as to prevent the latter operation.[2] The jejunum was seized two inches from the duodenum and held upon a pair of tongue forceps until the wound in the parietes was united; the jejunum was then stitched to the lower or right end of this wound by interrupted sutures. On the third day the bowel was opened and food given through the fistula.

The patient did not suffer from the operation, being fed partly by the mouth and rectum; he did well until the ninth day when some food entered the peritoneal cavity, which proved fatal. Not more than 10 ozs. could be given at a time without indigestion.

Rupture of the small intestine may consist of a rent in the walls involving only the serous and muscular coats (Fig. 499), or it may involve all the coats allowing fecal extravasation (Fig. 500), or the bowel may be torn completely across. If the rupture is incomplete the symptoms at first may consist of only the shock of the injury and vomiting, as no fecal extravasation takes place owing to the integrity of the mucous membrane. Hemorrhage may occur into the cavity or retro-peritoneal. If the rupture is complete the symptoms are severe from the first, as shock, tympanitis, hurried respiration, rapid pulse, vomiting, anxious expression of face. The sign of rupture of the greatest importance is tympanitic resonance over the liver; if dulness or flatness on percussion over the liver persist the evidence is against perforation.[3] Emphysema of tissues is also a valuable sign of rupture as it is due to the escape of gas from the intestine into the surrounding tissues, especially into the retro-peritoneal cellular and connective tissue.[4] The other symptoms should be carefully observed and proper weight be given them in forming an opinion as to the presence of rupture. If the evidence is in favor of rupture, or if there is a reasonable probability that rupture exists, abdominal

---

[1] Langenbuch; F. A. Southam.

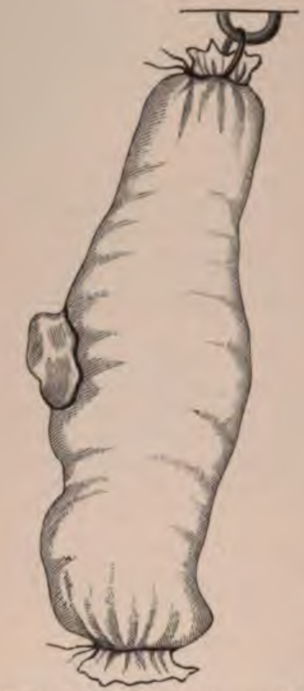
[2] C. H. Golding-Bird.

[3] A. Flint.

[4] F. S. Dennis.

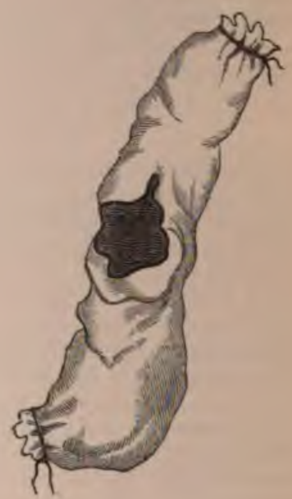
section should be made in the median line, according to the ru
given, the cavity cleansed out, and the rent sutured.

Fig. 499.



Rupture of the serous and muscular coats of intestine.[1]

Fig. 500.



Rupture of intestine.[1]

Wounds of the jejunum and ileum from penetrating instruments are frequent, owing to the great length of these bowels, their floating condition, and the large space over which they are spread. In general the wounds are oblique, but occasionally they are transverse, and sometimes, though rarely, longitudinal; they vary also from the smallest puncture to lesions inches in length, or even to complete division of the tube.[1] The danger is in proportion to the liability to extravasation of the contents of the bowel, and this depends upon the extent and nature of the wound. If the wound, whatever its direction, does not exceed four lines in length, or a third of an inch, nature, aided by appropriate therapeutic measures will, in many, if not in a majority of cases, be fully competent to effect a cure; but when the opening is six lines in extent, whether transverse, oblique, or longitudinal, there is almost invariably an escape of fecal matter, followed by fatal peritonitis.[2] In punctured wounds the opening is contracted by the circular and longitudinal fibres and closed by the eversion of the mucous lining; in transverse wounds, there is slight gaping from the contraction of the longitudinal fibres, but the calibre is diminished by the contraction of the circular muscular layer, and the pouting of the mucous membrane impedes the escape of fecal matters; in complete transverse section of the gut, the divided extremities are so separated and puckered as to render it difficult to distinguish the upper from the lower portion, except by the escape of feces; in large longitudinal wounds, the contraction of the circular muscular fibres causes wide gaping of the edges, and permits the escape of the contents of the bowel.

---

[1] F. S. Dennis.

[2] S. D. Gross.

Volvulus was found in a case of penetrating stab wound of the abdomen, the viscera having escaped injury, and death being due to this peculiar complication, which, it is believed, was the result of the original injury.[1]

The most important immediate symptoms of lesion of the bowels are shock, pallor, nausea, small and tremulous pulse, sudden tympanitis; secondary symptoms are discharge of blood from the anus, pain in the abdomen, dull and aching or sharp and colicky, tenderness, posture so as to relieve pressure. But the diagnosis is positive only when the bowel protrudes from the external wound and can be inspected, or when there is an escape of the contents of the bowel externally. If the bowel cannot be examined, it is well to ascertain, first, the position of the parietes at the time of the accident, the size and shape of the instrument; then, if the opening in the wall of the abdomen is large, place the part and body as nearly as possible in the position they were when the injury was inflicted, and, avoiding all officious interference, carefully explore with the index finger, aseptic, or a director, to determine whether the wound involve the muscles only or the muscles and peritoneal cavity. The treatment of all punctured and incised wounds of the intestines, attended with protrusion, consists in closing the intestinal wound by suture, and reducing the protruded viscus, unless its structure is irretrievably disorganized, and the adoption of the alternative of establishing an artificial anus is compulsory; even if the wound is not more than a line and a half in length, the bowel ought not to be returned without the suture, lest fecal extravasation occur.

As the suture is intended to prevent extravasation, there must be the most perfect adaptation of the edges of the wounded intestine; when finished, the threads must be cut close to the knot, and the bowel returned to its natural bed, without any measures being taken to retain the wounded portion near the external wound; on the replacement of the bowel the latter must be treated as if no other injury had occurred.[1]

In wounds of the intestines, unattended by protrusion, there is great liability to extravasation; the external wound should be enlarged when there is reason to believe that a wound of the intestine or viscera exists, and the internal wound should be closed by a proper suture.

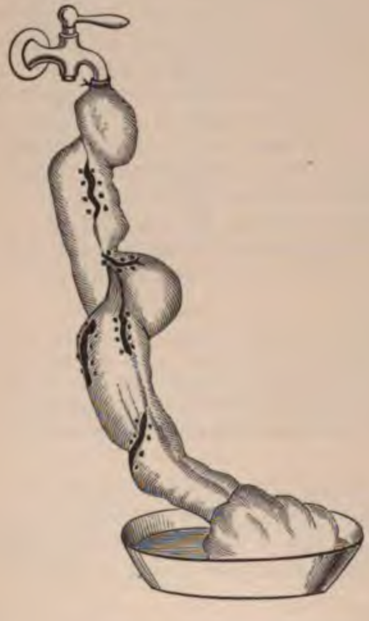
It is impossible to determine the nature and extent of the internal injuries of stab wounds by mere inspection and the immediate symptoms. Hence it is now a mooted question whether the surgeon should not perform abdominal section in all cases of stab wounds in which there is doubt as to the extent of the injuries existing. If it were decided in the affirmative the practice would undoubtedly be established of opening the peritoneal cavity in all penetrating stab wounds, as there must always be a reasonable doubt as to the existence of intra-

---

[1] F. S. Dennis.

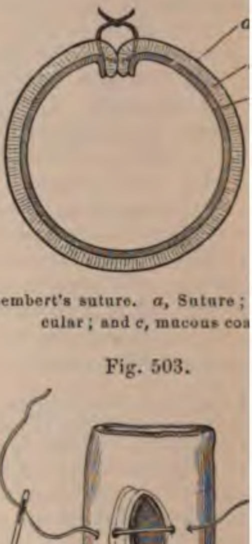
peritoneal wounds. It is truthfully alleged against the operation th
wounds are less liable to inflict severe injuries upon the viscera than shot w
but it is not justifiable on that account to overlook the fact that stab w
are always liable to fatally involve these organs. Undoubtedly the safe
practice is to regard all penetrating stab wounds of the abdomen as havi
volved the viscera, and to proceed in the treatment in accordance wi
view. This rule cannot be fully carried out in practice without explori
wound, and also the viscera sufficiently to determine satisfactorily the ex
the injury. We may conclude that if any doubt remains in the mind
surgeon, it is justifiable and proper, now that exploratory laparotomy c
made with such comparative immunity, to resort to it and give the patie
only chance of recovery by ascertaining the exact nature of the injury, whi
be the only proper and safe guide to rational and successful surgical treat
In making an exploratory incision it should be borne in mind that the en
ment of the original wound for an examination of the peritoneal cavity w
enable the surgeon to exclude in all cases fecal extravasation, perforatio
vulus, or hemorrhage; these may all exist, and no evidences of their pr

Fig. 501.



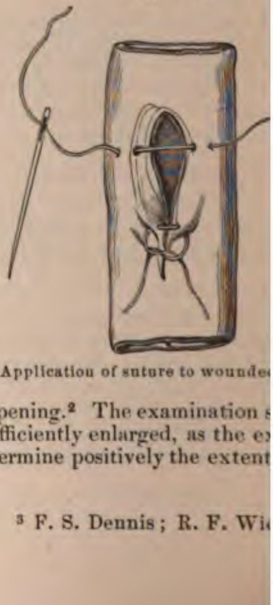
Stab wounds of bowel closed by suture.[2]

Fig. 502.



Lembert's suture. *a*, Suture ;
cular ; and *c*, mucous coa

Fig. 503.



Application of suture to wounde

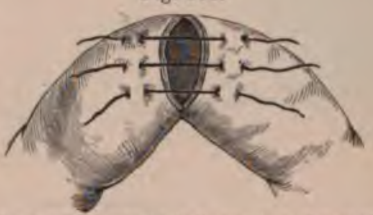
be manifest upon inspection through a small opening.[2] The examination s
therefore, be thorough, and the wound be sufficiently enlarged, as the ex
tion progresses, to enable the operator to determine positively the extent
injuries.[3]

---

[1] N. Senn. [2] F. S. Dennis. [3] F. S. Dennis; R. F. Wi

The wound of the intestine may be longitudinal, transverse, or oblique to the axis of the bowel (Fig. 501). In either case the suture should invert the margins of the wound so as to bring serous surfaces in contact. This result is best accomplished by a suture which includes only the serous and muscular coats at a distance of a quarter of an inch or more from the margin of the wound (Fig. 502). When these sutures are tied the serous surfaces invert (Fig. 503), and union is prompt and firm. The same suture is applicable to the transverse incision (Fig. 504). A double suture may be employed, especially in complete section of the bowel, the application of which will be best understood by the illustration (Figs. 505, 506).

Fig. 504.

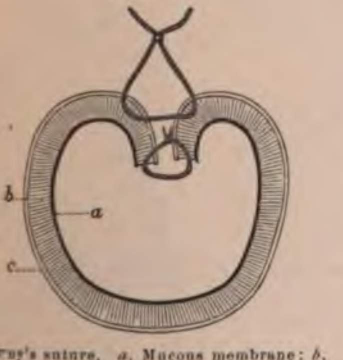


Lembert's suture, including peritoneal coat of intestine alone.[1]

If there is difficulty in using this suture, the needle may be passed completely through all of the tissues, and out again and the edges inverted when the knot is tied.[2]

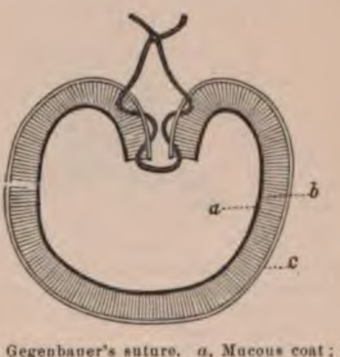
If the wound involve the entire circumference, proceed as follows: Determine which is the upper end of the gut; dissect away the mesentery a third of

Fig. 505.



Czerny's suture. *a*, Mucous membrane; *b*, muscular coat; *c*, serous coat.[2]

Fig. 506.



Gegenbauer's suture. *a*, Mucous coat; *b*, muscular coat; *c*, serous coat.[2]

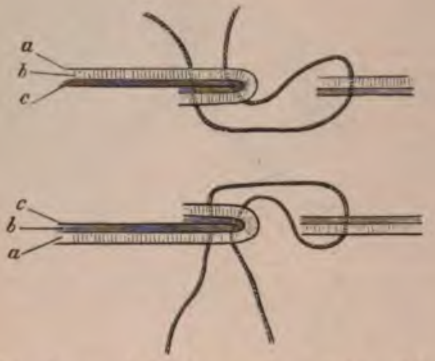
an inch from each end and arrest the bleeding that ensues; then, holding the upper extremity by the left hand, with the right insert a stitch through it two-thirds of an inch from the divided margin (Fig. 507) and give the loop into the hands of an assistant; introduce a second stitch in like manner at the opposite or mesenteric side of the bowel; then with the fingers, or with flat forceps, invert the lips of the lower portion, which is a difficult procedure; when accomplished, maintain the inverted hem between the left index-finger introduced, and the thumb, and along the finger, as a guide, introduce the inner end of the first loop inserted in the upper portion of the bowel, and in like manner the second; by gentle traction upon the two loops, invaginate the upper portion within the lower (Fig. 508); the loops may now be tightened and knotted or twisted, or the hem may be traversed by the outer ends of the two loops (Fig. 508) and the stitch then tightened and secured by torsion or by knot; bring the ends of the ligature out at the lower angle of the external wound; withdraw the threads on the fourth or fifth day by gentle traction.[2]

---

[1] T. Bryant.

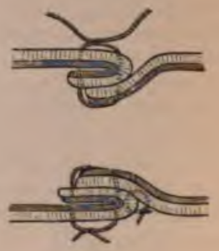
[2] J. E. Erichsen.

Fig. 507.



Jobert's suture for complete transverse division of the intestine. *a*, Serous; *b*, muscular; *c*, mucous coat.[1]

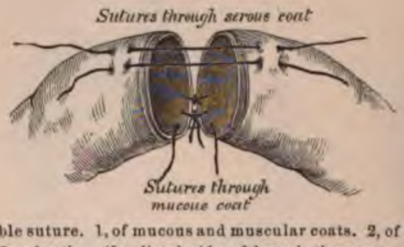
Fig. 508.



Suture tightened. The figure shows a Lembert's suture introduced to give additional security.[1]

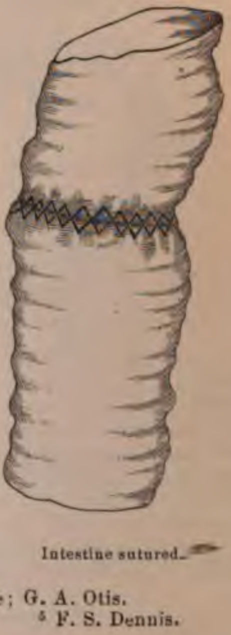
At the present time a double continuous suture[3] is preferred when there is complete section of the bowel (Fig. 505). Two sutures have been employed in these cases, the first through the mucous coat and the second through the serous coat, or the continuous suture may be used and duplicated (Fig. 510).

Fig. 509.



Double suture. 1, of mucous and muscular coats. 2, of serous, as in Lembert's. (In distal side of bowel the serous suture should precede the mucous; in proximal, the mucous suture should be applied first.)[4]

Fig. 510.



Intestine sutured.

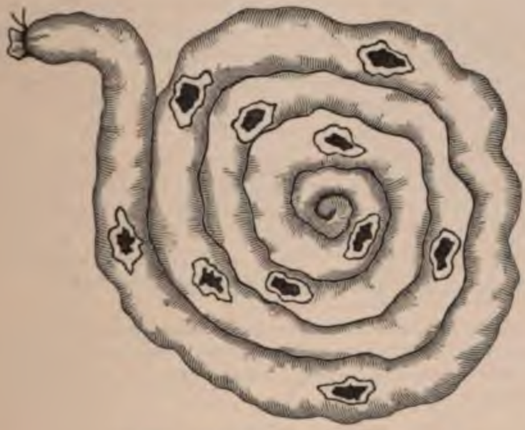
Shot wounds of the small intestines are severe in proportion to the size of the ball; large projectiles generally cause hopeless eviscerations; musket-balls commonly partially or completely divide the calibre of the small bowel; pistol or carbine balls may make single or twin perforations.

---

[1] J. E. Erichsen.
[2] Jobert de Lamballe; G. A. Otis.
[3] Czerny-Lembert.
[4] T. Bryant.
[5] F. S. Dennis.

Shot injuries of the duodenum are commonly accompanied with mortal lesions of adjacent parts; the jejunum is very liable to perforation by shot, and these wounds are often complicated by lesions of the adjacent viscera or of the mesenteric arteries, but there is not immediate extravasation owing to the emptiness of the bowel; the ileum, though somewhat protected posteriorly and laterally, is fully exposed in the umbilical, hypogastric, and right iliac regions.[1] A single ball has made ten perforations in the ileum (Fig. 511).

Fig. 511.



The ileum, showing ten perforations.[2]

The most important question now relating to shot wounds of the abdomen is as to the propriety of always opening the peritoneal cavity, with a view to a positive diagnosis and the direct and immediate treatment of lesions of the viscera if they are found to exist. The experience of the past has been that shot injuries of the small intestines are always fatal if treated upon conservative principles,[1] but the experience of the present is that some patients may be saved by exploring the abdominal cavity, cleansing it of all effused matters, and closing the wounds of the viscera. Recoveries have followed the bold and aggressive treatment by abdominal section, and suturing the wounds of the bowel,[3] even when those wounds numbered thirteen.[4] These results give a renewed interest to the question of abdominal section in shot wounds penetrating the abdomen, and, added to the evidence already accumulated, would seem to settle the rule of practice in favor of immediate exploratory section of the abdominal wall. This rule receives the greater emphasis at the present time owing to the comparative freedom of that operation from danger.

It can be justly said that the surgeon who allows a patient to die from the effect of a visceral injury of the abdomen produced by a stab or a bullet wound, without at least a proposition to resort to abdominal section, has failed to discharge the duties imposed by the teachings of modern surgery.[1]

---

[1] G. A. Otis. [2] F. S. Dennis. [3] W. T. Bull. [4] J. B. Hamilton.

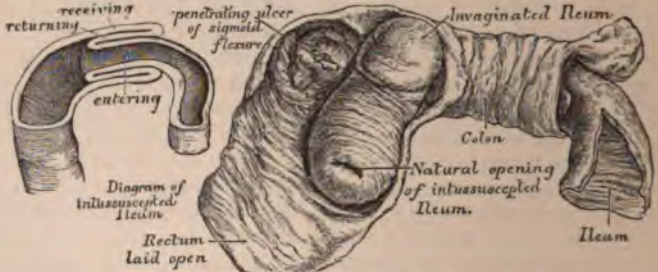
The operation is to be performed according to the rules given. In closing shot wounds of the intestine it is important to remembe that the margins may be so injured as to slough; in cases where th slough will probably be slight the margins will be so turned into th vessel by the suture that when it falls it will enter the cavity. In some cases shreds may be cut away with scissors. If the slough i very large, or if there are two wounds at the same point, section o the bowel must be made.

One of the most serious complications liable to be encountered in sho and stab wounds of the abdomen is hemorrhage from veins whic have been opened in remote and inaccessible parts of the cavity Frequently the injured vessel is retro-peritoneal, and large quantitie of blood become extravasated in this region. All efforts to find th punctured vessel are liable to fail, and though the lesions of the intestines may be satisfactorily dealt with, the loss of blood prove fatal. The surgeon should be prepared with aseptic sponges, th accumulated blood should be quickly removed, and immediate searc made for the source of hemorrhage. It may be possible to place th finger, or a sponge on a holder, upon the bleeding point and secur the vessel. If the vessel is a vein, and situated behind the perito neum, search for it will prove very hazardous.

The one obstacle yet to be overcome in the management of these cases is th control of the hemorrhage from large venous trunks, and until this object i accomplished, the science of surgery in this operation cannot be said to hav arrived at a state of perfection.[2]

Intussusception of the jejunum and ileum is most fre quent in adults, at the average age of thirty-four;[3] but it may occu

Fig. 512.


receiving
returning
penetrating ulcer of sigmoid flexure
Invaginated Ileum
entering
Colon
Natural opening of intussuscepted Ileum.
Diagram of intussuscepted Ileum
Rectum laid open
Ileum

Intussusception, with diagram showing the entering, returning, and receiving layers of ileum into colon.[4]

in the infant.[5] Owing to the comparative narrowness of the tu into which the invaginated portion of the bowel descends, strangu tion and congestion are speedy and intense, and sloughing and se ration of the strangulated part are consequently most frequent[1] (Fig. 512). It follows that this intussusception generally runs an acute course; impermeability is immediate and permanent, and death may follow in from three to six days, with or without peritonitis or perforation; in other cases the invaginated portion sloughs, either in strips and shreds, or in tubular sections, between the eleventh and twenty-first day.[2] The general symptoms of intussusception combine a variable degree of obstruction and inflammation; the patient is seized with a sudden, violent pain, often exactly localized in the region corresponding to the intussusception, and, even when most agonizing, sometimes distinctly recognized as a straining or tearing sensation, rarely accompanied by rigors; vomiting follows, which may subside if the inflammation is early and intense, but more frequently continues and becomes stercoraceous in the course of three or four days. The tumor caused by the intussusception is a physical sign of the greatest value; though of small size in many cases, especially in the earlier stages, and often obscured by the distension of the intestine, yet a careful examination will usually detect its presence.

---

[1] N. Senn. [2] F. S. Dennis. [3] W. Brinton.
[4] T. Bryant. [5] J. L. Smith.

The most characteristic features of intussusception of the small intestines are the violence of the symptoms, the rapid progress of the disease, more copious hemorrhage from the bowels, blood sometimes in the vomited matters, more complete obstruction, the discharges containing little or no fecal matters, the absence of tenesmus, the tumor small and situated within the abdomen and in the right hypogastrium.[3] Sloughing and discharge of the invaginated portion occasionally occur, followed by recovery. The question of reducing the invagination demands early consideration, and must be determined with due regard to the fatality of the disease, the possibility of recovering in each individual case, with or without sloughing of the invaginated portion, and the fact that rough, forcible, ill-timed proceedings will do more harm than good.[2] The indications of treatment are: (1) Quiet spasm to prevent the increase of invagination, and favor both the reduction of the swelling and the restoration of the passage; opium and belladonna are the most useful remedies; to children, they must be given in small quantities and with great care, but for adults they must be used watchfully in powerful doses;[2] hypodermic injections of morphia are generally to be preferred; (2) Attempt reduction by gently but forcibly kneading the bowels, changing the position of the patient from time to time.

The value of the various methods may be estimated as follows: (1) Crude mercury, like drastic purgatives, should never be administered with a view to force a passage. (2) Injections of air and fluids are of doubtful value, for they rarely, if ever, pass the ileo-cæcal valve from the colon to the ileum unless the ileo-cæcal sphincter is relaxed by opium or anæsthetics.[2] (3) Puncture of the intestine with an aspirating needle may be made to withdraw accumulated gases; if carefully performed with a fine, disinfected needle, the operation is quite without danger, and gives immediate though temporary relief.[2] For the operation, select the smallest aspirating needle and employ the aspirator, in order to create powerful suction; if the pump is not accessible, the common bulb syringe[4] may be attached and will generally prove efficient; dip the needle in boiling water or a disinfectant solution; insert the needle, by a slight rotary motion, into the most prominent and resonant point of the abdomen and pump out all of the gas; withdraw the needle instantly while working the pump, in order that no matters contained lodge in the cellular tissue; a small trocar and canula may be used, but they are not as efficient as the needle and aspirator.[1] (4) Massage under an anæsthetic, with changes in the position of the body, has been successful where no adhesions had formed.

---

[1] J. S. Bristowe.

[2] O. Leichtenstern.

[3] W. Brinton.

[4] Davidson.

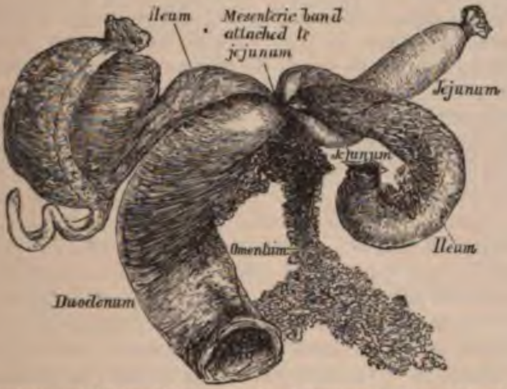
In conducting the treatment of a case diagnosed as intussusception of the small intestines, it must be borne in mind that reduction can be easily made only at an early period, before the adhesions have become firm. It is important therefore to lose no time in resorting to the more simple methods, described as massage, change in the position of the body. If these fail to relieve the surgeon should resort to abdominal section. Laparotomy has these advantages, viz: 1, the intussusception may be relieved by traction; 2, the involved bowel may be resected; 3, the bowel may be opened and attached to the wound, forming an artificial anus. The usual operation should be performed, the incision being in the median line below the umbilicus; great gentleness must be exercised in disengaging the bowel to avoid injuring its structure. It may be undertaken at the earliest age, having proved successful in the infant of six months; but it is important that it should be performed as early as practicable, for success depends largely upon the condition of the bowel; and when the strangulation is tight, the parts speedily become so altered by swelling, adhesion, and softening, that no amount of force short of that liable to cause rupture, will suffice to liberate them.[2]

If the usual measures fail[3] to effect a reduction, no time should be lost in resorting to abdominal section with a view to facilitate disinvagination by direct manipulation; if by traction, direct compression, dilatation of neck of *intussuscipiens*, separation of adhesions, etc., reduction is not accomplished, circular resection of the invaginated bowel, or the formation of an artificial anus above the invagination present themselves as the only means to save life within the range of operative surgery; the formation of a preternatural anus is preferable in cases where a large portion of the bowel has become invaginated, and again where the general condition of the patient is so grave that the more severe operation of enterectomy is contraindicated.[3] In fifty-one cases where laparotomy was done, reduction was successful in twenty-six—eighteen children with four recoveries, and eight adults with five recoveries, so far no child less than six months old has recovered after operation; in the twenty-five cases where reduction failed to be accomplished, or where no attempt was made, in four the abdomen was closed without any further attempt being made; in all of them the result was fatal; of eleven cases of resection only one recovered, and this was where the disinvaginated bowel was resected on account of malignant disease; in nine cases enterotomy was performed, as reduction was found impossible, and circular resection was deemed impracticable; in all, except one, death occurred a few hours after the operation; in the latter case life was prolonged for two and one-half days, the patient being an adult female.[3] So far success has attended abdominal section for invagination in cases where disinvagination by direct manipulation was accomplished, an experience which argues strongly in favor of an early operation before reduction is rendered impossible by additional pathological conditions; it may be stated as a rule that temporizing measures should not be relied upon for more than two days.

[1] J. G. Blake; H. J. Bigelow. [2] H. B. Sands. [3] N. Senn.

Strangulation of the small intestines may be caused by peritoneal false ligaments, by the omentum and mesentery, by slits and holes in different organs, by diverticula, by the appendix vermiformis, by internal hernia, and by twisting, knotting, and compression (Fig. 513).[1]

Fig. 513.



Case of strangulation of the bowel by lymph band constricting ileum about three inches from cæcum and a coil of jejunum.[2]

Strangulation by bands[3] occurs, with scarcely an exception, in the small intestines, and the segment involved is in the great majority of cases the lower part of the ileum; this is due to its relation to the cæcum and appendix, its descent into the pelvis, and the presence of a diverticulum.

In occlusion of the jejunum, collapse, vomiting, and anuria usually appear early and soon reach a considerable height; the course is usually rapid, the meteorism inconsiderable, limited to the epigastrium, or entirely wanting, and the abdominal wall even retracted; the vomited matter is stained with bile, greatly discolored, but never feculent; when the occlusion is of the lower part of the ileum, the meteorism is noteworthy, sometimes limited mainly to the meso- and hypogastrium, with comparative hollowness of the regions corresponding to the colon; the course is also rapid, collapse, vomiting, and suppression of urine appearing early, but the vomited matters soon become feculent.[1] These cases are rarely relieved by any other treatment than laparotomy. The gentlest efforts may be made by kneading the abdomen while the patient is under an anæsthetic. If this fail, the operation should be performed. If bands are found, they should be tied with catgut ligature, and then divided or excised; if the bowel is twisted, it should be replaced, and, to prevent the twist recurring, sutures[4] may be passed through the mesentery of the bowel and the parietal peritoneum of the left abdominal wall.

Obstruction of the jejunum and ileum may occur from intestinal and gall stones and foreign bodies swallowed; they lodge most frequently in the lowest part of the ileum, one or two inches above the ileo-cæcal valve, owing to the diminution of the calibre of the intestine as it approaches the cæcum, and its fixation by a short mesentery.[1] Intestinal stones, enteroliths, rarely occlude the bowel suddenly, but give rise to premonitory symptoms, as emaciations, hypochondria, sometimes signs of diminished permeability, or typhlitis; often a tumor may be felt in severe cases, and as the patient may have a cachectic appearance, causing suspicion of cancer.[1] Gall stones may occlude the ileum suddenly, after severe hepatic colic, followed by meteorism, at first limited to the hypo- and meso-gastrium, with vomiting, which becomes feculent; or the occlusion may be preceded for a long time by symptoms of diminished permeability, and repeated but temporary symptoms of total obstruction.[1] When a foreign body has passed through the pylorus, it has to traverse the horseshoe coil of the duodenum, producing most intense agony when the substance is of an elongated form; it is liable to be arrested here, but in most instances passes onward, and there is then nothing to obstruct it until it reaches near the ileo-cæcal valve; but it may become arrested in any part of its course along the small bowels. The symptoms induced are very vague and uncertain, and give no evidence of either the presence or situation of the foreign body; they may appear as those of acute and chronic enteritis, cæcitis, and colitis, and even peritonitis.[2] Ordinarily bodies excite symptoms of obstruction, and may give rise to a constriction by cicatricial bands or chronic peritonitis.[1] If the obstruction is acute, administer opium at once, and in full doses; if chronic, and the symptoms of increasing obstruction of the passage grow more severe, give doses of castor oil, or calomel, and enemata of cold water. Gentle but persistent rubbing and kneading of the bowels, with change of position, has frequently proved successful in dislodging the obstruction and even overcoming an intussusception. Operative interference is justified only when three or four days have passed without any relief from ordinary means, the constipation being complete, and vomiting of fecal matter continuing. Laparotomy, as a final remedial measure, should then be unhesitatingly performed, for many cases of intestinal obstruction undoubtedly prove fatal, which, by timely operative interference, would result favorably. Abdominal section having been made as directed, with antiseptic precautions, the seat of obstruction must be sought for as follows: without allowing the bowels to escape search for the portion in a state of collapse; if this is found trace it upwards, for it is below the obstruction.[3] Or, first pass the hand to the cæcum; if this is distended, the seat of occlusion is in the large bowel, and may be found by passing the fingers along its course; but if it is empty the trouble is in the smaller bowel, and the search should be made first for a collapsed portion, which, being found, will lead to the point of obstruction. The intussusception having been discovered, and the bowel being uninjured, gentle efforts should be made to dislodge the upper bowel from the lower by traction upon the two parts, or by pulling the ensheathing layer downward, while squeezing the lower end of the intussuscepted bowel upward.[4] If the bowel cannot be dislodged, but is not gangrenous,

---

[1] O. Leichtenstern. [2] T. Bryant. [3] F. Treves. [4] Roser.

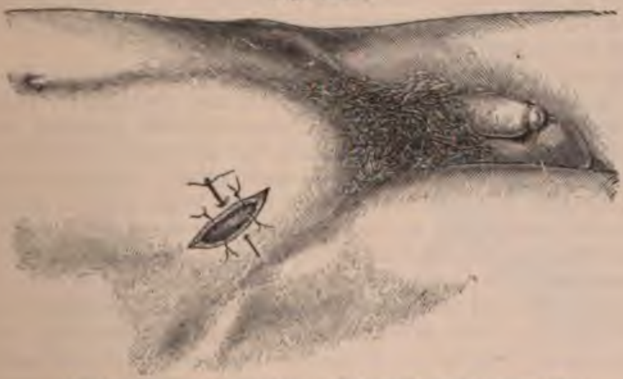
[1] O. Leichtenstern. [2] A. Poland. [3] J. W. Hulke. [4] H. B. Sands.

the obstructed part may be removed by section, and the two healthy portions of bowel united. If it is gangrenous, section may still be made, the diseased portion removed, and the two incised ends united, or an artificial anus may be made.

The following suggestions[1] will prove useful in performing these operations for obstruction of the bowels: 1. Make the incision in the middle line below the umbilicus; 2. Fix upon the most dilated or the most congested part of the bowel that lies near the surface, and follow it with the finger as a guide to the seat of obstruction; 3. If this fail, draw the intestine out of the wound, carefully covering it, until increase of distension or congestion or both in one of the coils gives an indication that the stricture lies near; 4. If there be considerable distension of the intestines, evacuate their contents by incision, and suture the wound. Never consider an operation for intestinal obstruction inside the abdomen complete until the bowels are relieved from over-distension; 5. Be expeditious, for such cases suffer seriously from shock. The whole operation ought to be concluded in half an hour.

Enterotomy, incision of the bowels, may be practised for the removal of foreign bodies, or for the purpose of establishing an opening through the abdominal wall from which the bowels are discharged. This latter operation[2] is chiefly performed in the right inguinal region in obstruction low down in the small intestines, or high up in the large intestines, and to which enterectomy and lumbar colotomy are believed to be inapplicable. Make an incision (Fig. 514) in the right side an inch in length, a little above the crest of the ilium parallel with Poupart's ligament, the length of the incision being subsequently increased to three or four inches; divide layer by layer the skin, cellular tissue, muscles, and aponeurosis until the peritoneum is exposed; tie all the vessels and disinfect the wound with bichloride solution; the peritoneum is next seized with small forceps, raised, and incised; a silver wire or aseptic thread is now passed through the intestine and abdominal wall; sutures are then passed through

Fig. 514.



Inguinal Wound made in Nélaton's Operation of Enterotomy.[3]

---

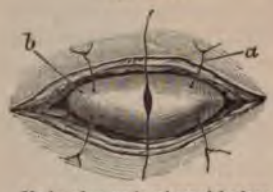
[1] J. G. Smith.

[2] E. Nélaton.

[3] T. Bryant.

each side of the incision; two others, *a*, *b*, are made, one at the superior, and the other at the inferior angle of the wound, passing first through the abdominal wall, then through the intestine, and finally through the opposite wall (Fig. 515). The intestine is now firmly fixed to the abdominal wall, and it is only necessary to make a small opening into the bowel.

Fig. 515.



Mode of securing bowel before opening it.

Enterectomy, resection of small intestine, may be required for injury of the bowel by stab or shot wounds, in obstruction of the bowel by intussusception, or in gangrene of the bowel. There are two procedures; either the portion of bowel may be cut off and the ends united to each other, or the cut ends may be brought to the external wound and united to it as in enterotomy. The several steps of the operation have been given with illustrations (Figs. 506, 507, 508, 509).

The failures of this operation have been attributed, especially after resection for gangrene, to the want of blood-supply, owing to the detachment of the mesentery. To overcome this defect it has been proposed[1] to incise the two portions of intestine obliquely, and apply the cut edges so that the mesenteric attachment of one end should be united to the free side of the other.

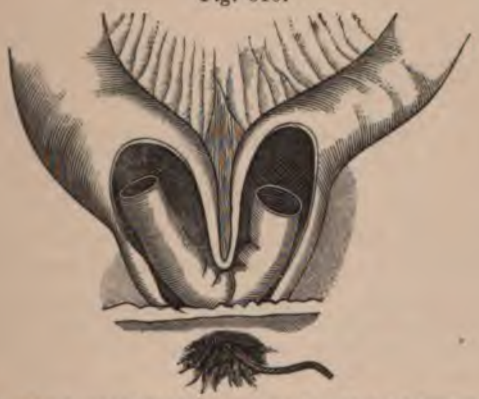
Intestinal fistula, artificial or false anus, remains after the operation of attaching the intestines to the external opening, and measures may be taken to restore the calibre of the bowel, and close the external opening. This result is attained when the septum is so far removed as to enable the contents to pass directly along the bowel without being diverted to the opening.

If the septum is slight, dilate both ends of the intestine by means of lint tents, regularly increased in size and retained by compress, and follow by introducing conical plugs into the external opening, thus forcing the septum back towards the abdomen, and leaving the two ends of the intestine opposite each other; continue treatment until feces pass freely from the upper to the lower bowel; subsequent compression with a pad and truss is in many cases followed by complete cicatrization.[2] India-rubber tubing may be used successfully.[3] The tube, fastened by a piece of stout silk which hung out of the opening, was passed, one end up the ascending bowel and the other down the descending (Fig. 516); it was retained a week at a time until the opening had partially closed; at the end of three months it was completely closed. The belief was that the continuous elastic pressure of the tubing against the projecting spine or eperon would pass it back, and so allow the feces to pass around the corner without flowing out of the artificial anus. If the septum is prominent and unyielding, it must be destroyed by the enterotome, selected and applied thus: Select an instrument with serrated edges worked by a screw (Fig. 517); place the patient on the back and distinguish the upper and lower ends of the bowel; now take one branch of the enterotome in the right hand and pass it carefully along the track of the bowel one to three inches, according to the depth of the septum; while an assistant retains this branch, introduce the other with the same care along the other bowel; now join the blades and tighten them sufficiently to destroy the septum by strangulation (Fig. 518); after a few days they compress the opposed serous surfaces firmly together, and finally the instrument becomes loose and finally falls; the after-treatment requires compress and truss until the wound heals.[1]

---

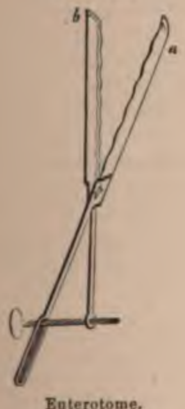
[1] R. T. Morris. [2] O. Leichtenstern. [3] M. Banks.

Fig. 516.



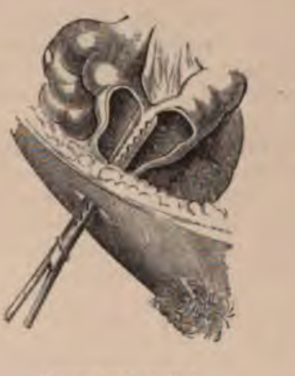
Plan of curing artificial anus by the introduction of a rubber tube into the bowel, held in place by a thread passing out of the opening.

Fig. 517.



Enterotome.

Fig. 518.



Enterotome applied.

Other methods are the ligature[2] passed through the septum and frequently tightened until firm adhesions have taken place between the opposed serous surfaces, and then division of the remainder by the bistoury; destruction of the septum by caustic,[3] and by excision;[4] suture of the margins of the wound in the abdominal wall;[5] anaplasty.[1]

---

[1] Dupuytren.
[2] P S. Physick.
[3] Vidal.
[4] Rayèr.
[5] Lecah.

CHAPTER XLII.

THE CÆCUM; THE COLON.

I. THE CÆCUM.

THE cæcum is the most capacious portion of the large intestines, being about two and a half inches in length and breadth.

It consists of a large pouch, occupying the right iliac region, where it is retained in position by a fold of peritoneum reflected in front, and by an attachment of loose connective tissue, though the peritoneum, by doubling posteriorly, sometimes renders the cæcum less fixed than ordinarily; the lower extremity curves inwardly and backwards, and is abruptly reduced into a worm-like prolongation, the vermiform appendix, four or five inches long, thick as a goose quill, of narrow calibre, usually somewhat coiled and retained by a fold of peritoneum.[1]

Wounds of the cæcum are frequently recovered from, even when projectiles pass directly through its cavity. This comparative immunity is due largely to the situation of the cæcum in the lower part of the abdominal cavity, and only partial investment by the peritoneum. The diagnosis depends upon the direction of the weapon or missile, and the discharges from the wound. The treatment is expectant, consisting of rest, anodynes sufficient to relieve pain, cold at first to prevent inflammation, followed by poultices, and if pus forms, evacuation.

Perforation of the appendix vermiformis[2] frequently follows the lodgment of foreign bodies in this tube, as grape-seeds, or even concrete mucus; the perforation may allow the body to escape directly into the peritoneal cavity, when fatal collapse immediately ensues; more frequently inflammation is set up, which results in the formation of an abscess.

This abscess may terminate as follows: (1) In a dried mass of semi-calcareous product; (2) the adhesions may suddenly break down and fatal extravasation into the peritoneal cavity follows; (3) it may open into the intestine and discharge; (4) it may penetrate the cellular tissue behind the cæcum, and pass upward behind the colon, or downwards towards Poupart's ligament, where it may find an opening at the anterior superior process or under the ligament, the perforation sometimes takes place directly.

The symptoms[3] depend upon the varying conditions of its progress, but in general the formation of an abscess would be indicated by the following signs: after some irregularity of the bowels, either diarrhœa or constipation, generally the latter, and perhaps after more than wonted exertion, severe pain comes on, in many cases suddenly, in the right iliac fossa; the pain may be confined to this spot, and be accompanied by excessive tenderness, radiating over the abdomen, and be very quickly followed by collapse, and signs of general peritonitis, as extremely anxious countenance, sunken eye, cold extremities, distended and tympanitic abdomen, clammy, partial sweats, failing pulse, and death in a few hours; or the tenderness and pain in the neighborhood of the cæcum are accompanied with fulness, and slight dulness in percussion; the skin is hot, the tongue slightly furred, pulse often compressible and somewhat excited; local peritonitis is set up in connection with ulceration or inflammation of the coats of the cæcum. Exploration by the rectum sometimes enables the finger to detect the tumor, and determine its location.

---

[1] J. Leidy.

[2] S. O. Habershon; G. Lewis.

[3] G. Lewis; S. O. Habershon.

Resolution may now occur with gradual subsidence of all the symptoms, or the fulness, tenderness, and pain may continue, and a more defined tumor become perceptible, which may at any time perforate the peritoneum and prove fatal, or open into the intestine, or may gradually distend the iliac fossa and approach the surface.

The treatment must be perfect quiet, castor oil to remove irritating matters from the bowels, followed by opium to relieve pain, and poultices to the tumor to hasten the process of the formation of thick abscess walls and bring pus to the surface. The abscess must be opened as soon as pus is detected, and as early as the eighth day if pus is not detected, and the disease has steadily progressed up to that time;[1] longer delay is dangerous, and at this period the abscess walls have commonly caused firm adhesions of the peritoneum.

It is safe always to explore, when there is a doubt, with the finest aspirating needle, or the hypodermic syringe; if pus is discovered, the abscess may be opened by the sharp-pointed bistoury entered at the place of exploration.[2]

The formal operation[3] is as follows: Make an incision five or six inches in length, if the swelling is large and pus has not been detected, commencing an inch internal to and above the anterior superior spinous process and extending downwards towards the pubes; continue the dissection through the several layers of the abdominal wall; raising them cautiously, and with a director, if necessary, until the abscess wall is reached; introduce an exploring needle, and if pus is found, puncture the abscess. If, after dissecting down to the peritoneum, pus is not found, the wound may be left open and the abscess will subsequently discharge through this wound. The abscess should be cleansed twice daily with bichloride solution, and the wound should be allowed to heal by granulations. It may be necessary to apply a truss for some time, owing to a tendency in some cases to hernia.

Cæcal abscess[4] may result from the extension of inflammation of its internal coat or by the ulceration and perforation of the walls.

In consequence of the angular course which the axis of the intestines takes at this point, the cæcum acts as a natural resting-place for the food as it passes through the intestinal canal; normally composed feces may be here retained sufficiently long to become hardened, or even converted into true fecal calculi; these masses and indigestible substances, swallowed in the food, such as kernels of grain, pins, pieces of bone, may collect in the cæcum, where they act as irritants to the mucous membrane and excite inflammation, and ultimately produce ulceration so deeply as to perforate the bowel.

---

[1] W. Parker.

[2] G. Buck.

[3] H. Hancock; W. Parker.

[4] W. Leube.

If the ulceration is rapid, extravasation may take place, followed by fatal peritonitis. The attack occurs suddenly, without premonitory symptoms, or may be preceded by constipation, dull pain in the abdomen, colic, and other symptoms of derangement; the immediate attack is ushered in by severe pain, limited to the right side of the abdomen, increased by motion, even in breathing, and aggravated to its greatest intensity by pressure upon the right inguinal region; palpation reveals a tumor, composed partly of impacted feces, and partly of inflammatory exudation; the percussion note is dull, or at least, dull tympanitic, and the movements of the right thigh are painful. The patient frequently becomes typhoid, and the disease is often mistaken for typhoid fever. The treatment should be rest, castor oil to remove all irritating matters from the cæcum, then opium to relieve pain and restlessness, and poultices to hasten the approach of the pus to the surface; the swelling should be explored with a fine aspirating needle, or common grooved needle, or hypodermic syringe; if pus is found, open the abscess with a sharp-pointed bistoury, at that point, or by free incision. If the swelling fill the iliac fossa, and no pus is found, operate as in abscess of the appendix, and if pus is still not found, keep the wound open to favor the escape of pus when it is formed.

Intussusception assumes two principal forms in this region: (1) ileo-colic, the passage of the ileum through the ileo-cæcal valve; (2) ileo-cæcal, the passage of the ileum and cæcum into the colon; the former is very rare, the latter the most common, especially in childhood and during the first year.[1]

These invaginations more often run a chronic course, and are distinguished from those of the small intestines by the prominence of tenesmus, which is rarely present in any marked degree where the small intestine only is implicated; by the greater size and fixation, and different site of the sausage-like tumor, which, if large, generally occupies the left side of the hypogastric, or left iliac region; by the hemorrhage, which, instead of being copious, is often little more than a scanty admixture scarcely sufficient to tinge the mucus passed from the bowels with violent and frequent straining; by the degree of obstruction which seems to be really absent owing to the patulous state of the axis of invagination; by the presence in the more marked and protracted cases of the invagination in the rectum.[2]

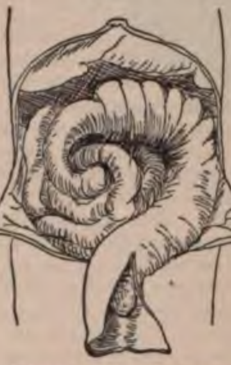
The tumor is rarely discovered in the region of the cæcum, owing to its small size, want of firmness, and its rapid progress along the colon, rendered easy by the great mobility of the cæcum; nor is it easily detected when it occupies either colic flexure, particularly the right, where it will be overlaid by the liver; more often it is found along the course of the descending colon, as an elongated swelling somewhat movable from side to side, frequently becoming harder and more prominent during a paroxysm of pain; the finger in the rectum may detect the tumor and define the ileo-cæcal valve, and if the other hand meantime is applied to the abdomen, the continuity of the rectal and abdominal tumor may be determined (Fig. 512).[1]

---

[1] O. Leichtenstern.

[2] W. Brinton.

Fig. 519.



Intussusception of cæcum.

The post-mortem appearances[2] of fatal ileo-cæcal intussusception were as follows (Fig. 519): The descending colon was enormously enlarged and full; the sigmoid flexure was distended and made a great curve nearly to the right side of the abdomen; the distended transverse colon, thrown into transverse folds, could be traced to the right side of the median line; the ileum, cæcum, and ascending colon were entirely intruded, and pushed into the descending colon, descending into the rectum within a few inches of the anus; on opening the rectum and sigmoid flexure, the termination of the intussuscepted portion was found to be almost black, the apex very tense and its opening marked by a fissure caused by the contraction of the mesentery; turning aside the bowel, it was found to be convex and twisted, from the dragging of the mesentery, and at the concave side was a large irregular ulcer at the most tense portion; there was general peritonitis, due to perforation of an ulcer in the sigmoid flexure.

The treatment is the same as ileum invagination, to which is added injections of air and water. The distension of the lower bowel must be carried to the fullest extent short of rupture, and should be undertaken early, before adhesions have formed; if water is used, place the patient on the back, in bed, or if a child on the lap of the nurse; elevate the hips 45°, to secure the aid of gravitation; provide lukewarm water, and with the common bulbous syringe, or, better, the fountain syringe, inject it gently until the abdomen is somewhat distended; now carry the finger gently but firmly over the abdominal walls along the direction of the colon, in order to force the liquid upward against the intussusception; if the water is discharged, the injection may be several times repeated.[3] If water fail, inflation may be resorted to, which produces a more equable and effective distension; the common bellows, with a tube, is efficient;[4] or carbonic acid gas may be employed, as obtained from bottles charged with the gas in the shops; by inversion a powerful current may be conducted through the tube of a rubber syringe.[3] The operation of laparotomy, in this form of invagination, should be undertaken as a last resort, but the delay should not be so great as to endanger the integrity of the bowel.

Median laparotomy is to be preferred when the location and nature of the occlusion are unknown as it admits of extensive and minute exploration. In lateral laparotomy exploration is less easy, but it is indicated in all cases of localized obstruction. When circumscribed adhesions, or any symptom renders it probable that the obstruction exists in one or the other side of the abdominal cavity, not only is this obstacle more readily reached, but if it is necessary to make an artificial anus the best conditions for such an operation are obtained.[1]

---

[1] H. B. Sands.

[2] S. O. Habershon.

[3] J. L. Smith.

[4] D. Greig.

The amount of distending pressure which it is safe to apply to the bowel in employing water is fixed as follows:[2] in the infant eight or nine pounds, and in the adult twelve or fifteen pounds. The fountain syringe is considered the only one that can be used in these cases with accuracy, and therefore it is the only one that should be employed; by it the amount of force used can be accurately measured, as every two and one-half feet in height of the reservoir above the point of delivery represents about one pound pressure on every square inch of the intestine below the point of obstruction; if the reservoir is suspended seven and one-half feet above the child, a force of three pounds to the square inch is exerted on the obstruction; the rubber tube being fifteen feet in length and vertical, the pressure will be six pounds to the square inch; with a tube of sufficient length any pressure can be brought to bear on the tumor as desired. It will be accurate enough for all practical purposes to estimate that a column of water two and one-half feet high exerts at its base in every direction a pressure of one pound to the square inch; hence the exact force used in giving an injection can be obtained in this manner. The only important feature about the siphon syringe is the long tube, or a number of pieces of rubber tubing that can be spliced. Not less than from twelve to twenty feet of tubing should be at hand; into the upper end of the tubing a funnel can be inserted in which to pour the water; or the water can be conducted into the tube from an ordinary pitcher on the principle of the siphon. A convenient way of getting sufficient elevation (for most rooms are not twelve to twenty feet high) would be to have one person carry the reservoir of water to the stairway while the patient could be in the hallway or in a room opening into the hall near the stairs. A glass vaginal syringe with a shoulder one inch from the end will be found a very important adjunct; by this simple contrivance an injection may be given without fear of wounding the intestine, without making painful pressure on the parts about the anus, without the escape of a drop of the liquid used, and with the utmost ease and convenience to the operator; its effectiveness is due to the fact that during the terrible expulsive efforts of the patient the stretched sphincter is supported by the large tube and the shoulder, and thus none of the liquid used can escape. The danger of using the common bulb-syringe is seen in the fact that with the hand a force of ninety pounds can be brought to bear upon the column of water.

II. THE COLON.

The colon ascends from the cæcum in the right iliac region in front of the right kidney to the under part of the liver, the ascending colon; it then crosses through the upper boundary of the umbilical region to the left hypochondriac region, the transverse colon, where it forms an angle and descends in front of the left kidney to the left iliac region, the descending colon; here it forms an S-like convolution, the sigmoid flexure, and enters the pelvis as the rectum.[3]

Wounds of the large intestine[4] are less fatal than those of the small, owing to the fact that there is less liability in wounds of this portion of the intestinal canal to extravasation of the fecal contents into the peritoneal cavity; this is due to the disposition of the muscular coat, and the firm attachments by which the gut is secured, which tend to preserve that parallelism between the wounds in the parietes and in the bowel, and that apposition of the intestinal and parietal surfaces that are such important safeguards; further favorable conditions are found in the facts that the colon is only partially invested by the peritoneum, and injuries of its ascending and descending portions especially do not necessarily jeopardize other organs. These wounds are generally attended by stercoral fistula, which commonly close after a time, without operative interference, reopening at intervals and then healing permanently. The differential diagnosis between wounds of the large and small intestines is often very difficult, and sometimes unattainable. These wounds often do well without interference, and enterorrhaphy will seldom be requisite unless the wounded colon protrudes; but there are exceptional cases in which extending the external wound and sewing up the rent in the gut is the only means of preventing extravasation.[1]

---

[1] Polaillan. [2] W. E. Forest. [3] J. Leidy. S. D. Gross.

In a considerable number of these wounds the abnormal communication between the bowel and the exterior of the abdomen remains open, and constitutes an artificial or preternatural anus; but there is an absence, or only slight development of the cresent-shaped septum commonly formed in cases of preternatural anus following mortification of the intestine in strangulated hernia.[1] As the chief obstacle to the permanent closure of abnormal anus is the septum, which prevents the contents of the bowel above from reaching the calibre of the bowel below, these lesions in which the septum is slight, are more curable than those which follow strangulated hernia. The treatment, therefore, depends upon the features of each case; if the opening is small, keep the parts clean, and restrain the escape of feces or food through the orifice by the application of gentle pressure, and closure will frequently occur; if the wound shows no tendency to close and the patient refuse operative interference, place a compress of linen in the opening with a larger pad over it, and apply a truss to retain dressings.

Fecal accumulations[2] must be treated by local means, and without delay, for the distended bowel becomes feebler, and the overstretched muscle wastes and becomes fatty. Enemata form one of the more efficient means; the best material is water, at a temperature of 100°; give no anæsthetic and place the patient in the knee and head, knee and elbow, or left lateral abdominal position. Enemata failing, resort to massage:—place the patient on the back, and the hands being oiled lay both palms on the abdomen, with the fingers widely opened, then pass the hands in various directions, the pressure being steady and deep, and the movements slow; continue fifteen or twenty minutes and repeat.[3]

The old treatment by metallic mercury is again recommended.[4] The mercury is now believed to act by becoming very finely divided, and so infiltrating the fecal mass as to loosen it and its connection with the bowel, and also induce peristaltic action. The dose may be varied from 50 to 300 grammes, and many times repeated. Electricity is of doubtful value.[2]

Simple stricture of the colon[5] results from the cicatrization after ulceration of the mucous membrane; the stricture may be a mere ring, or it may occupy several inches of the bowel. The symptoms may for a long time be vague, inconclusive, and even misleading; occasionally the symptoms come on quite suddenly, but in general the patient suffers for weeks, or months, or years, with occasional attacks of colicky pain, associated it may be with more or less constipation, or even diarrhœa; when the case is free from complications its progress is essentially chronic; but sooner or later symptoms appear which indicate impassable stricture; namely, insuperable constipation, painful peristalsis coming on periodically, and often rendering itself audible by borborygmi, and visible through the abdominal walls; abdominal fulness and uneasiness, followed by nausea and vomiting, and finally the ejection of stercoraceous matters. It is difficult to determine the seat of stricture, and the only guides are distension of the bowels above and collapse below; thus fulness and dulness in the course of the cæcum and ascending colon indicate stricture at the hepatic flexure; the same conditions of the transverse colon point to stricture at the splenic flexure, and the like state of the descending colon locates stricture at the sigmoid flexure.

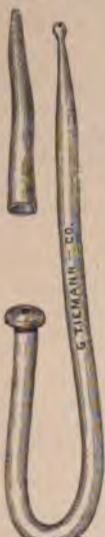
---

[1] G. A. Otis.
[2] F. Treves.
[3] Kriviakin.
[4] Matignon.
[5] J. S. Bristowe.

The flexible rubber tube[1] now renders it possible to fully explore the colon as far as the sphenic flexure, and perhaps further, and test its calibre (Fig. 520); different sizes may be used to determine the calibre; the tube must be introduced very gently, but being very yielding, no harm can be done unless unnecessary force is employed.

The treatment is, perfectly fluid or pultaceous food, easy of digestion, and well masticated; relief of constipation, by simple non-purgative enemata; avoidance of purgatives. If the stricture is at any point below the splenic flexure, dilation may be attempted with the rectal dilator and explorer (Fig. 520).[1]

Fig. 520.



Rectal tubes.

The dilators used are manufactured out of pure rubber, with a canal running the whole length, and gradually increasing in size by an eighth from a quarter of an inch to an inch in diameter; each dilator is fitted with a gum sheath of corresponding dimensions. The points of the dilators taper for an inch and a half, or two inches, conically; the whole length of the sheath, both inside and outside the bowel, or any portion of it, may be filled with water; in the latter case a thread of silk is to be twisted around the dilator at any point that it may be desirable to limit the distension.

The method of introducing the dilator is as follows: Place the patient, reclining on his left side, upon an ordinary operating-table, the thighs flexed and the buttocks just overhanging the lower edge. The smallest-sized instrument is smeared with grease, and its point inserted into the anus and gently pushed onward in the following manner: The right hand grasps the dilator close to the anus, and the whole perineum is to be pressed upwards, which will advance the point of the instrument; the left hand now steadies it, while the right is slid downwards for a lower hold, the perineum of course settles with it; the dilator is again pushed forward in the same manner until the obstruction is passed; this may be greatly facilitated by sinking the fingers of the left hand deep into the left iliac region, and drawing upwards, as though an effort was being made to stretch out the sigmoid flexure, while pressure is maintained at the same time upon the dilator in the manner described; another practical point of prime importance is to employ an abundant stream of water, projecting it through the conduit of the instrument as warm as can be comfortably borne, whenever its point is arrested from any cause; the water flowing from the distal aperture will distend the bowel, efface its folds, and break down any hardened feces that may exist, obstructing the ascent of the dilator; while the operator is engaged with the dilator, an assistant may manage the syringe and throw in the water in such quantities as may be needed; it must be borne in mind, however, that no great volume should be used at once, otherwise the bowel will be excited to energetic contraction, and compel the dilator to be withdrawn before it has been properly lodged. In preliminary trials, the dilator may be permitted to remain two or three minutes, and afterwards, when greater tolerance is established, a longer stay may be allowed. After several introductions of one size of the dilators, perhaps seven or eight, the next largest may be taken, and so on until the stricture has been sufficiently expanded. The application of the instrument may be repeated twice or thrice a week, according to circumstances, such as the irritability of the rectum, temperament of the individual, and intercurrent attacks of diarrhœa or other trouble.

---

[1] P. S. Wales.

If the stricture becomes impassable, an operation must be undertaken for its relief; this consists in opening the colon, colotomy, at a suitable point, and the formation of an artificial anus If the stricture is in the ascending or transverse colon, the operation should be on the right side, and if at the sigmoid flexure, on the left side.

Colotomy, section of the colon, for the relief of obstruction of the intestine by stricture or morbid growths, should be performed in the lumbar region,[1] for the purpose of opening the colon on the posterior surface, where it is uncovered by the peritoneum.

The important anatomical features of this region are as follows: It is a quadrilateral space bounded above by the last rib, below by the iliac crest, behind by the longissimus dorsi and sacro-lumbalis muscles, and anteriorly by a vertical line drawn from the centre of the crest of the ilium to the last rib; in this space the colon lies in front of the kidney and separated from it by adipose tissue; the centre of this space corresponds with the fascia transversalis, and is separated from the quadratus lumborum muscle by some adipose tissue; anteriorly and externally the colon is in contact with the small intestines, and its distance from the spine varies according as it is contracted or distended; if contracted, the space between the peritoneal folds behind is slight, but when distended, the portion uncovered by peritoneum is increased.[2] The conclusion as to the precise location of the colon, based on more than fifty dissections, is, that it is always normally situated half an inch posterior to the centre of the crest of the ilium, or a point midway between the anterior and posterior spinous processes.[3] Before operating it is well to mark out the two processes, then find the centre point between them and draw a vertical line full half an inch behind this centre spot.[2] By attention to these rules, the operation will not be found very difficult, and when the gut is much distended and the patient thin, nothing can well be easier; this is not the case when the bowel is collapsed and the patient muscular or fat. The numerous failures to find the colon are due to the fact that it has been looked for too far from the spine.[3] When the bowel is collapsed there is an advantage in distending it by an injection of warm water or of air.[3] This must be done when the patient is under the influence of an anæsthetic; distension by air is most cleanly and manageable; to retain the injection the rectum must be plugged with wet lint, retained by the finger ot an assistant.[2]

Proceed as follows,[4] the operation being on the left side: Place the patient on the right side, with a pillow under the loin, that the left loin may be thrown into greater prominence; make an incision four inches long, somewhat obliquely between the crest of the ilium and the last rib, half of the incision being on each side of the vertical line marked out (Fig. 521); the direction of the incision has been

---

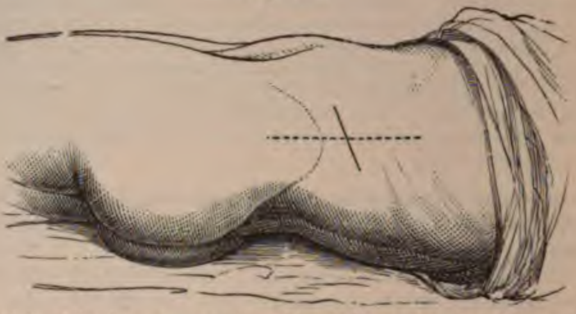
[1] M. Callisen; M. Amussat.

[2] E. Mason.

[3] W. Allingham.

[4] C. Heath.

Fig. 521.



Line of incision in lumbar colotomy. Dotted line indicates situation of descending colon.[1]

vertical,[2] transverse,[3] and oblique;[4] but the slightly oblique incision, running parallel to the last rib, should be preferred; divide the skin, subcutaneous fat, the external oblique and latissimus dorsi muscles, thus exposing the internal oblique; divide it the whole length of the wound until the fascia lumborum comes into view, which carefully divide on a director; the loose fat is now exposed about the kidney and colon in the anterior part of the wound, and the edge of the quadratus lumborum behind; keep the edges of the wound open with spatulæ, and displace the fat with the finger and seek for the bowel; in cases of obstruction with distension, there is no trouble in doing this, the bowel presenting at the wound covered only by fascia transversalis; this fascia varies in thickness in different cases, and has sometimes been mistaken for peritoneum; if the bowel be empty, tear through the fascia transversalis carefully with the finger-nail just in front of the quadratus lumborum, introduce the forefinger, and hook the intestine; if this does not succeed, turn the patient over upon his back and the bowel will, in all probability, fall on the finger; bring the bowel into the wound, roll it round and expose the posterior surface, which is generally uncovered by peritoneum, and, when the bowel is distended, this surface is much larger; with a large curved needle pass a stout silk thread through the skin to one side of the mark, across the bowel, and again through the skin at a corresponding point on the other side of the mark, repeating the proceeding at the other end of the incision; thus the colon is held to the margins of the wound before being opened; make a transverse incision into the bowel between the threads, and, the finger being introduced, the two loops can be drawn out, and, on dividing them, four threads only are

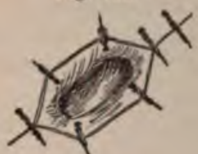
[1] J. E. Erichsen.

[2] M. Callisen.

[3] M. Amussat.

[4] M. Baudens.

Fig. 522.



Bowel united to external wound.

required to be tied to fix the bowel to the wound; close the rest of the incision on each side of the bowel by ordinary sutures (Fig. 522).

The colon may be recognized[1] by (1) its distension and greenish hue; (2) its peculiar bands; (3) its quiescence during respiration while the small intestines move.

The after-treatment[1] differs in no respect from that of any other wound; it may be covered at first with lint spread with oxide of zinc ointment, and with carbolic acid; this is changed when soiled; after the bowels have been moved freely, a pad of oakum may be placed over the opening and a bandage applied; the stitches confining the bowel to the integument may be removed on the fourth or fifth day, or be left to separate; if the case progress favorably, the patient may sit up in bed on the fifth or sixth day; if fecal matters pass down into the rectum below, an anema will remove them. If the disease for which the operation is performed is recovered from, the artificial anus frequently closes, proving that the effort to close the opening, when no longer required, should be attempted.[1]

Instead of performing an ordinary lumbar colotomy, the entire calibre of the gut has been cut through and its central end attached to the external wound, and the peripheral end, after closure of its lumen, returned into the cavity of the belly; the advantages of the procedure, in addition to diminishing the disposition to prolapse of the gut, are that it removes the mechanical, septic, and chemical irritation to which the carcinoma is subjected by the retention and passage of feces in the ordinary operation, and prevents the annoyance and discomfort which arise from the accumulation of feces between the lesion and the external sphincter.[2]

Cancer of the colon is most frequent in the sigmoid flexure. These growths are almost exclusively gland cancers; the proliferation proceeds from the large glands of the large intestines, and grow in the shape of tortuous and branched tubes; the calibre of the gland is often maintained, but it fills with mucus, and the cylinder cells may maintain their form and become very large; at first the muscular coat of the intestine is hypertrophied, but subsequently it is also affected by the ulceration, which begins early.[3] The symptoms are those of chronic obstruction, to which are added the cancerous cachexia and the detection of a tumor. The treatment is resection. Though the operation is in no sense curative, it undoubtedly prolongs life and renders it comfortable.[4] To derive its full value, the operation should be performed at an early period, before the stricture becomes impassable. If it is delayed until the vital powers are worn out by long-continued suffering, or until absolute constipation occurs, the shock may be so great that life is forfeited.

In 33 operations, 17 died, the mortality being about 51 per cent.; of those who recovered, and whose subsequent history was reported, one survived one and a half years, the others died within one year from a recurrence of the disease.

---

[1] E. Mason.
[2] Madelung.
[3] T. Billroth.
[4] T. B. Curling; Sir J. Paget.

Resection of the colon, colectomy, is an operation very similar to enterectomy. As it is more frequently performed for cancer of the colon, the following are the details of a successful resection of part of the rectum and colon, showing the steps of the operation :—[1]

The section was four inches long in the median line from an inch below the umbilicus downward; three fingers of the left hand were carried into the cavity, the tumor caught and drawn out of the wound, and surrounded with flat disinfected sponges; it was a knobbed mass four inches long, extending nearly to the sigmoid flexure; temporary ligatures of heavy soft sublimated silk were carried through the meso-rectum above and below the mass, and five inches of intestine with the tumor were cut away after the meso-rectum had been tied off with several ligatures of silk applied parallel to the bowel dividing it as far from the latter as possible; two small glands were dug out of the stump and more of the meso-rectum removed. It was now decided to create an artificial anus, as the suturing of the two ends of the bowel together would have to be made some four to five inches from the anus which was deemed unsafe. The upper divided end of the bowel was secured by three or four sutures to the superior angle of the wound. The divided end of the lower bowel was closed by suturing the mucous membrane, and then applying a double row of serous sutures. The abdominal wound was closed with continuous catgut suture to the peritoneum and others to the muscles and skin. The patient recovered, though there were some disturbances about the wound for several days, and a subsequent fecal and purulent discharge from the bowel.

CHAPTER XLIII.

THE RECTUM.

THE rectum commences opposite the left sacro-iliac articulation, and is directed at first obliquely downwards, and from left to right, to gain the middle line of the sacrum; it then changes its direction and curves forward in front of the lower part of the sacrum and the coccyx, and opposite the prostate gland turns backwards and downwards to reach the anus; it is from six to eight inches in length, and is rather narrower than the sigmoid flexure at its upper end, but becomes dilated into a large ampulla or reservoir immediately above the anus.[2]

Exploration of the rectum may be with the finger, hand, or speculum. In exploring with the finger,[3] place the patient on the side, with the knees well drawn up; lubricate the finger well with oil, and pass it gently through the anus, avoiding any rude movements; by pushing with force and burying the knuckle in the perineum, a distance of four or five inches from the anus may be reached; if now the patient bear down, the exploration may extend six inches.

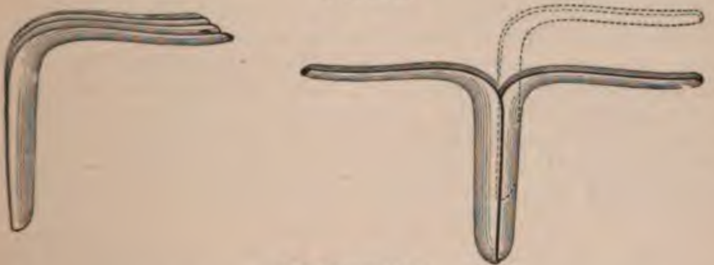
Exploration with the hand[3] must be performed with great caution, to avoid rupturing the mucous membrane or other tissues; the patient being fully anæsthetized, place him on the back with the knees drawn upwards; the hand and arm being well oiled, give a conical form to the tips of the fingers, and apply the palm of the thumb to that of the fingers, its tip placed between the index and little fingers; gently insinuate the tips into the anus with a semi-rotatory motion, and continue the process until the hand is lodged in the rectum; the dilatation of the sphincter should be very gradual, and should occupy at least five minutes; when once through the sphincter, the windings of the gut should be followed by a semi-rotatory movement of the hand, and by alternate semi-flexing and extending the fingers; in many cases the hand can be passed into the sigmoid flexure, and possibly, in rare instances, into the descending colon; should the hand meet with a feeling of constriction about the junction of the first and second portions of the rectum, no force on any account should be used to overcome it, as this can only be accomplished by rupturing the peritoneum, which is here reflected from the intestine.

---

[1] R. F. Weir. [2] Quain's Anat. [3] G. Simon; W. J. Walsham.

Specula have a limited value in their application, and when employed, anæsthesia is a most valuable aid.[1] For thorough exploration place the patient, when under the full influence of an anæsthetic, on a table of proper height, or on a uterine chair, and in a good light, the body in the prone position, with outspread arms and the hips properly elevated; introduce a speculum vaginæ, or one of similar form (Fig. 523), and elevate the posterior wall; the whole internal surface of the rectum as high up as its termination in the sigmoid flexure may be exposed to view.[2]

Fig. 523.



Rectal speculums.

A nest of three. Two adapted for use.

Medication by the rectum is chiefly required for the purpose of procuring an evacuation of the bowels, or for administering remedies which it is not advisable to give by the stomach. The common syringe, with barrel and piston (Fig. 524), is now employed only to give small quantities of fluid, as in administering an anodyne injection. For injections in bulk, and for general use, the rubber bulbous syringe[3] is preferable (Fig. 525); or, the apparatus[4] may consist of an elastic air-bulb, *a*, a stand pipe, *c*, which rests in the bowel, the pipe, *d*, and the nozzle, *e* (Fig. 526).

The enema, though of daily use, is rarely administered with requisite skill, being too often intrusted to those ignorant of its nature and purposes; it must be accurately adapted in quantity and quality to the capacity and tolerance of the bowel and be so administered as not to pain, irritate, or injure the parts.[1] An enema consists of the menstruum, as water, boiled starch, mint tea, and the ingredients, which are laxative, stimulating, anodyne, or nutritious; the quantity used must depend upon the effect desired, these facts being borne in mind, namely, (1) the larger the quantity the more promptly the bowels act, and *vice versa;* (2) three times more in quantity are required by the rectum than the stomach; (3) absorption by the rectum requires double the time of the stomach. The ordinary injection is given as follows: Inject the fluid through the tube until all air is expelled; place the patient on the left side, with the thighs flexed, and hips well elevated; gently insert the tube, passing it first slightly forward towards the umbilicus, then backward towards the cavity of the sacrum; when the tube has entered two or three inches, force the fluid slowly into the bowel until the requisite quantity is given; withdraw the tube very slowly, and if there is any tendency to escape, press a cloth firmly against the parts.

---

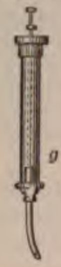
[1] W. H. Van Buren.

[2] Quain's Anat.

[3] Davidson.

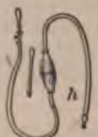
[4] Mattson.

Fig. 524.



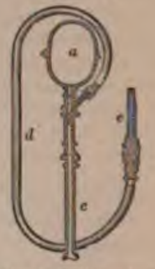
Common syringe.

Fig. 525.



Bulb syringe.

Fig. 526.



Elastic air bulb syringe.

The patient should always be placed on the left side, with the hips raised and the thighs flexed, in order to give such position to the rectum, sigmoid flexure, and descending colon that the fluid itself will gravitate towards the splenic flexure of the colon. If the patient lie on the back or upon the right side, the force of gravity, aided by the natural resistance of the bowel, defeats the object in view.

Alimentation by the rectum is required in diseases of the œsophagus preventing swallowing, and in diseases of the stomach which prevent the retention or ingestion of food; life may in this manner be maintained for long periods. The nutritive injection should be composed of materials which need no digestion, as milk, eggs, mutton and chicken broths.

Pancreatic meat emulsion[2] should be made as follows: To five to ten ounces of finely chopped meat add one-third of that weight of the fresh pancreas of the ox; remove the fat and mix with about five ounces of water, and reduce the whole to the consistence of a thick soup. Or, the following preparation may be used: Crush or grind a pound of beef muscle fine, add one pint of cold water, allow it to macerate three-fourths of an hour, now raise it to the boiling point and let it boil two minutes and stand.[3]

---

[1] S. D. Gross. [2] W. Leube. [3] E. R. Peaslee.

The quantity used should be three or four ounces every four hours, and it should be tepid. The bowels should first be moved by a laxative or enema; the injection should be very gently thrown into the rectum; at first it may not be retained, but by repetition and pressure upon the anus, tolerance is established; or opium may be added to the enema; if at any time the rectum becomes irritable the injection may be carried to the colon;[1] as a substitute for drink, water may be thrown into the rectum; the rectum need not be washed out before each enema.

Imperforate rectum is caused by a membranous partition which may be just within the anus or an inch or more above; it varies in thickness, but is usually thin; the symptoms are retention of the meconium and vomiting. Examination with the finger or probe, or a small elastic catheter or bougie determines its nature; if the membrane is thick, it may not be possible to decide whether the intestine is continuous above till an incision is made, but if it is thin it will bulge down upon the finger, especially when the child cries.[2] Delay the operation a day or two, until the meconium dilates the lower part of the intestine; if the septum is thin, break it down with the end of the little finger; if thick, puncture with a sharp-pointed bistoury, the blade being wrapped with thread, and cautiously carried into the passage on a grooved director, or along the finger; enlarge the puncture by a crucial incision; dilate with the end of the little finger, or a dressing forceps; pass the finger, or a bougie of suitable size, daily, for several months.

Absence of the rectum may be partial, which is most common,[3] or complete, the anus being normal. When only partially absent, the other portion usually terminates in a cul-de-sac, at a greater or less distance from the surface of the body, or it may be prolonged as a narrow tube or imperforate cord, and blended with adjacent parts; if wholly absent, the canal may open in some abnormal situation.[2] The diagnosis is made by examination with the finger or a bougie. If the occlusion is not thick, it is only necessary to incise the intervening tissues, and dilate. If the part is very thick and hard, dilate the anus, if necessary add lateral incisions; separate the mucous membrane, and draw down the rectum; cut off that portion including the septum, and attach the margin by suture to the skin.[4] If the rectum is wholly absent, and the bowel cannot be reached by dissection, a last resort is to make an artificial anus.

Laceration may involve the mucous membrane only; or all of the coats of the rectum; incomplete laceration is generally the result of the expulsion of hardened feces, and is vertical when it results from undue distension of the anus during the violent efforts of the expulsive muscles, and transverse when a fold of mucous membrane falls under a mass of indurated feces at the moment of its forcible extrusion; complete laceration occurs in parturition, and from external violence, as blows, the passage of an injection pipe or catheter, or foreign bodies lodged in the rectum, or penetrating through the anus. The treatment of incomplete laceration consists in protecting the wound from irritation by emollient enemata, cleansing the surface, and the application of nitrate of silver, if healing does not progress favorably; in complete laceration it may be possible to close the wound by suture, but if not, it must be treated as a fistula.

---

[1] F. Barker. [2] T. J. Ashton. [3] G. Bushe. [4] M. Amussat.

Abscess near the rectum, if acute, appears as a throbbing swelling, hot and painful, with fever; if subacute, there may be little or no pain; if it is difficult to detect the presence of pus, owing to the elasticity of the cellular tissue and its depth from the surface, introduce one or two fingers into the rectum and make counter pressure, by which means fluctuation is easily discovered; when pus is detected, open the abcess by puncture; the after-treatment consists of poultices, care being taken to prevent the external wound healing before the cavity of the abcess, by the insertion of tents occasionally.[1]

As a rule, however, to which exception is rare, these abscesses do not heal, but become fistulous tortuous passages, owing to the constant motion to which the healing part is subjected by the proximity of the restless sphincter muscle, and the muscular pouch of the rectum, which is continually varying in volume; to guard against censure, warn the patient of this contingency before opening the abscess.[2]

Stricture of the rectum is the result of any cause which induces a thickening and contraction of the coats of the bowel in that region, as injuries, specific or malignant disease.

(1) Simple stricture follows the organization of the products of inflammation in the submucous cellular tissue and muscular coat.

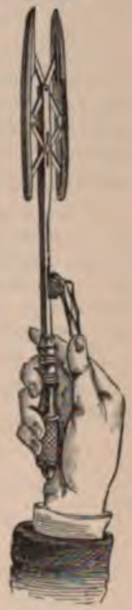
In severe and long-continued cases, the fibrous deposit is more extensive and dense, and in addition to a very narrow contraction there is a large amount of thickening of the coats of the bowel, but there may be a considerable contraction with slight consolidation of the surrounding tissues; in rare instances, the stricture is due only to fibrous bands running across the bowel, or it involves only a portion of its circumference; the extent of bowel affected varies from one or two lines to half an inch, an inch and a half, or even three or four inches; the bowel above is generally more or less dilated, with increase of its muscular coat, while the mucous membrane is vascular, thickened, or even ulcerated.[3]

Its usual location is within two or three inches of the anus, and it can readily be detected by the finger; rarely, it is found higher up, even in the sigmoid flexure.[1] The symptoms are referable directly, or indirectly, to the mechanical obstruction to the function of the bowel which it occasions, the more prominent being, at first, costiveness, or difficulty in evacuating the lower bowel, the feces escaping in narrow, tape-like coils, when the stricture is near the anus; and later, costiveness alternating with diarrhœa, due to the inflamed and altered mucous membrane above the stricture, which now yields mucus mingled with pus and blood.[2] The existence of stricture is definitely made out, by the finger within the rectum, when within its reach; the canal feels narrow, indurated, and unyielding, though in some instances the finger may pass through the obstructed portion; if the stricture is higher up, it may be brought within reach of the finger by the bearing down effort of the patient;[4] or, the patient standing erect and forcing down, may render the examination with the finger conclusive.[1] Stricture at higher points is diagnosed with difficulty, as there is no positive evidence of its existence but that obtained by the touch;[2] reliance must be placed upon symptoms, explorations with the olive or rubber bougies, aided by inspection by means of the speculum, when the patient is in the prone position, on the knees and elbows. The treatment is dilatation, which is best effected with bougies; they meet two indications, namely, mechanical stretching of the contracted tissues, and stimulation of absorption of the recently organized material which constitutes the substance of the stricture; the bougies should be smooth, conical at the extremity, and of half a dozen different sizes, varying from that of the largest urethral bougie to the diameter of an inch and a half.[3] The gum-elastic and metallic instruments in common use do not compare in efficiency and pliability with the soft rubber[4] dilators (Fig. 520), and should never be used when the stricture is beyond the reach of the finger. Select a dilator of sufficient length to extend beyond the stricture, and of a size to pass through it without force; previous to its introduction, empty the bladder, and wash out the rectum with warm water; warm and oil the bougie, to render it pliable; place the patient on the left side, or require him to lean over a chair, or kneel on his bed; the buttocks being separated, introduce the bougie upwards and a little backwards with the convexity towards the sacrum, avoiding all force; when suddenly checked, withdraw the instrument somewhat, and give it a different direction; if the stricture is more than five or six inches from the anus, turn the point of the instrument a little forwards and to the left side, to avoid the sacrum and enter the sigmoid flexure.[5] The bougie should not be left in the rectum, in contact with the altered parts, more than fifteen or twenty minutes, and it is sufficient in most cases to introduce it every second day. At some stages of dilatation a dilator (Fig. 527) has been useful as it brought equal pressure to bear on all parts of the stricture. If these means fail the knife may be employed in making very limited incisions, or nicking the most resisting points of the stricture, especially when it is diaphragmatic, linear, or bridle-like,[3] or of traumatic origin with a dense cicatrix, and situated at the verge or within a short distance of the anus. Operate thus: Carry a straight, narrow-bladed bistoury on the left forefinger within the stricture and notch it at several points; introduce a bougie for a minute or two, and on its withdrawal pass a suppository into the rectum.[6]

---

[1] T. J. Ashton. [2] W. H. Van Buren. [3] H. Smith. [4] G. Bushe.

Fig. 527.



Rectum dilator.

Linear rectotomy[7] is recommended for the cure of stricture which is greatly indurated, with softening of the mucous membrane by growths, ulcerations, and fistulous passages; it is adapted only to strictures within three and a half or four inches of the anus, or where the peritoneum is not liable to be implicated; the patient lying on the back, and being under the anæsthetic, with the index finger of the left hand as a guide, pass a straight bistoury to the upper limit of the stricture in the posterior median line; now incise the bowel slowly until the entire thickness is divided throughout the whole extent, including the anus. The after-treatment requires the occasional passage of a rectal bougie, during the period of repair, to prevent recontraction.

---

[1] J. P. Batchelder. [2] R. Quain. [3] W. H. Van Buren.
[4] P. S. Wales. [5] G. Bushe. [6] H. Smith. [7] L. Verneuil.

Other methods, having limited approval, are, forcible dilatation to the extent of laceration of the stricture, great caution being observed in view of the possibility of fecal extravasation and pelvic cellulitis and abscess.[1] Such dilatation may be effected with dilators, of which there is a variety, but all are constructed on the same principle. Or the dilatation may be effected with a membrane which is applied to the stem of the instrument, through which there is a canal into which water can be forced;[2] the soft rubber dilators[3] have a hood which may be dilated in a similar manner and are preferable.

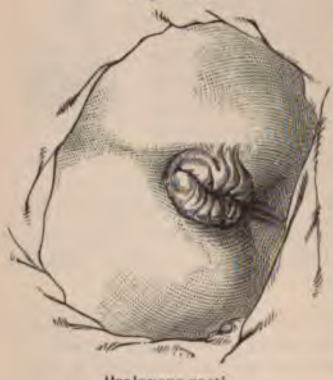
It must be constantly borne in mind, in the after-treatment, that simple stricture is never so cured as to require no further treatment after complete dilatation is effected; there is a constant tendency to contraction which must be resisted for years by the occasional introduction of the bougie by the patient.[4]

(2) Venereal or syphilitic stricture results from the healing of chancroidal ulcers of the rectum, the walls having become inoculated by the secretions from external sores, or impure connection, or from inflammation extending from chancroids about the anus to the areolar tissue of the rectum, followed by organization of its products, or ulceration of the mucous membrane.

It occurs almost exclusively in females, its most frequent site being between one and two inches from the anus; its symptoms do not materially differ from simple stricture, but the presence of chancroidal cicatrices on the genitals confirms the diagnosis; the treatment is by dilatation, anti-syphilitic remedies being valueless.[5] In old strictures which resist all treatment and become sources of permanent ill health, lumbar colotomy may with propriety be performed.[6]

Prolapse of the rectum (Fig. 528) is the protrusion from the anus of the coats of the rectum; the length varies from one to six inches, or even more, and the shape and appearance depend upon its size, and the condition of the external sphincter; it may form a rounded swelling which overlaps the anus, or have the form of an elongated pyriform tumor, the free extremity being tilted forwards or to one side; if the sphincter is relaxed, the surface will have the normal color of mucous membrane, but if contracted, the color may be violet or livid; the exposed mucous membrane is often thickened and granular, and sometimes ulcerated, and the connective tissue infiltrated.[7] It is most frequent in children, owing to less curvature of the sacrum, the cartilaginous state of the

Fig. 528.



Prolapsus recti.

---

[1] W. H. Van Buren.
[2] J. Arnott; W. R. Whitehead.
[3] P. S. Wales.
[4] G. Bushe; T. J. Ashton; H. Smith.
[5] L. Gosselin; E. Mason.
[6] W. Allingham.
[7] T. B. Curling.

coccyx, the straighter direction of the rectum.[1] The causes are (1) constitutional, as general debility, and (2) local, as diarrhœa, or constipation, polypi, stone in the bladder, stricture of the urethra.[2] The treatment must first be directed to the replacement of the bowel. Place the patient on his side, or on his knees and elbows; the buttocks being separated, grasp the tumor in a piece of oiled linen, make firm compression, and, having reduced its volume, push it within the sphincter; if there is much congestion, apply cold, or if inflammation is present and prevents reduction, resort to leeches, followed by hot fomentations of the decoction of poppy heads; should contraction of the sphincter interfere, give an anæsthetic, and if relaxation is not sufficient, divide the sphincter by carrying the knife on the finger nail introduced within the bowel; when the bowel is returned, apply a pad of lint and retain with the **T**-bandage.[1] The next step is the removal of the cause, which, in children, may generally be effected, rendering any but the simplest local measures necessary for a permanent cure.[3] In the adult, if of long standing, prolapse of the rectum will rarely admit of being remedied, except by an operation,[1] which will result in such a degree of the adhesive process as shall prevent the descent of the bowel.[4] The object to be obtained is to reduce the redundancy or relaxation of the mucous membrane, promote adhesion between the several tissues, and brace up the anus and sphincter.[2] In the treatment of simple prolapsus, where there are one or more large folds of mucous membrane, and the tissue is extremely vascular, presenting the appearance of smooth velvet, or is superficially ulcerated and readily bleeds, apply the strong nitric acid[5] carefully to the whole or greater part of the diseased membrane with the same precautions as to hemorrhoids; if the surface is extensive, make the application to a part only, and repeat.[2] In more severe forms apply a clamp to the mucous membrane and destroy the included portion with the actual or galvanic cautery.[6] Rest should be maintained, opium given to relieve pain, and hemorrhage should be suppressed by cold.

Other methods are as follows: With toothed forceps, pinch up one, two, or more folds of mucous membrane, on opposite sides of the bowel, and include them in a firm ligature;[7] when the prolapsus is very large, and a considerable portion of the mucous membrane has been converted into tissue, approaching integument, remove loose pendulous flaps of skin which exist around the margin of the anus,[8] and portions of the mucous membrane,[9] as follows: seize the fold of skin on each side of the anus with forceps, and with curved scissors remove both the skin and mucous membrane; in very severe cases four or six applications of the scissors may be necessary.[2]

Polypus of the rectum is composed of a somewhat loose, fibrous, or fibro-cellular tissue, covered by natural mucous membrane. It occurs more frequently in children, is generally single, and pediculated, and located just above the sphincter; it may be soft and liable to bleed, or firm and resisting; the symptoms at first are slight, but later there is passage of blood, tenesmus, the escape of the tumor which may be mistaken for prolapsed bowel or hemorrhoids; examination of the escaped tumor, its reduction, followed by exploration of the rectum with the finger, determine its nature; if beyond the reach of the finger, the presence of the polypus may be suspected if the fecal matter is grooved. The treatment is removal.[1] Sometimes the pedicle is so frail that the tumor is detached in the examination.[2] Bring down the tumor by an enema; seize it with forceps and apply a ligature to the pedicle; if the tumor slip under the finger in the effort to bring it down, pass polypus forceps over the finger, seize the tumor, and twist it off its pedicle; arrest hemorrhage by cold or astringent injections.[1]

---

[1] T. J. Ashton.
[2] H. Smith.
[3] T. Holmes.
[4] R. Quain.
[5] B. C. Brodie.
[6] T. Bryant
[7] T. Copeland.
[8] W. Hey.
[9] Dupuytren.

Hemorrhoids, piles, result essentially from a diseased condition of the venous radicals of the rectum, and have been described in that connection (page 270).

Foreign bodies found in the rectum are of two kinds: (1) concretions, biliary, intestinal, and fecal; (2) substances swallowed or introduced through the anus, as pins, nails, fruit-stones, coins, small bones, or pieces of wood, cork, meat, bone, horn, ivory, and metal, pots, cups, bottles, ferrules, rings.[3] The symptoms of the former are gradual in their accession, preceded by signs of derangement of the stomach, liver, and bowels, and weight, distension, and pain in the rectum, followed by obstinate constipation, great straining, with more or less prolapsus of the mucous membrane and congestion; exploration with the finger reveals the nature of fecal accumulations, and the presence of foreign bodies; information as to substances swallowed can seldom be obtained, as the patient is generally unconscious of the fact. When the foreign substance has been introduced into the rectum the symptoms are more rapid in their development, and the patient may explain the nature and method of introduction of the foreign body.[4] In the removal of such substances great care must be exercised, that the coats of the bowel be not injured. The following instruments may be required: Blunt hooks, lever, gimlet, cutting forceps, strong long scissors with probe points, a six-inch narrow saw, polypus and lithotomy forceps, speculum, strong waxed ligatures, metallic tubes, a probe-pointed bistoury; to all of which a crooked finger and small hand are important adjuncts.[3] Fæcal accumulations are best broken up with a lithotomy scoop, or the handle of a firm spoon. As a rule, extract the larger portion and remove the remainder with injections.[5] The removal of concretions and solid substances must be effected with the finger, or with forceps. Should the substance be a bottle, or a jar of glass, or earthenware, insert slips of thin ivory, wood, or gutta-percha, between it and the bowel, and thus form a tube around it, which will facilitate its extraction and protect the intestine from injury in case the body should be broken; the anus being very dilatable, it will rarely be necessary to divide the sphincters, unless the foreign body is sharp and angular and has penetrated the intestines.[4]

Cancer of the rectum is almost exclusively of the form of gland cancer, as it commences in the glands which grow in the shape of tortuous and branched tubes; the interstitial connective tissue is strewn with small, round cells, sometimes softened and often very vascular; the muscular coat may be at first hypertrophied, but subsequently it is also affected by the ulceration. The first symptoms are usually constipation, discharge of mucus and slight hemorrhage, which leads to the treatment for hemorrhoids before the diagnosis is made out; but the induration and nodular infiltration, leaf-like proliferations, commencing close above the sphincter ani, soon extend to the whole circumference of the mucous membrane, so that a thick and prominent ring, forming a stricture of variable length, may be felt; at later periods an ulcer is found with elevated edges and indurated base, and the parts around are infiltrated with medullary substance, while at some points there is cicatricial tissue; the inguinal and retroperitoneal glands are affected rarely and late in the disease; death generally results from the stricture, from marasmus due to hemorrhages, and putrefaction of the cancerous tissue. This new formation can only be removed by extirpation. The only contra-indications to extirpation are adhesions of the tumor to parts surrounding the rectum, extreme debility, and the presence of secondary growths in internal organs.[1]

---

[1] H. Guersant.
[2] T. Holmes.
[3] G. Bushe.
[4] T. J. Ashton.
[5] T. B. Curling.

Extirpation of the rectum may involve only a small section of the tube or the entire bowel, or both the rectum and anus, according to the extent of the disease; complete extirpation has given the most satisfactory results.[2] Operate as follows: The bowels having been thoroughly cleared by injection, place the patient, anæsthetized, on the back and in the position for lithotomy, the limbs being supported; empty the bladder, and in the male introduce a sound as a guide; if the anus is involved, commence an incision at the centre of the perineum and carry it along the raphé to the anus, encircle the anus, and continue along the median line to the coccyx; dissect along this incision until the rectum is exposed; now with the fingers or handle of the scalpel continue to expose the bowel until a point is gained above the diseased mass; draw the bowel down through the wound, pass ligatures through the healthy portion and carefully divide it, tying all bleeding vessels; the stump of intestine is now to be attached to the integument along the margin of the wound by sutures passed from within outwardly. If the anus is not diseased, it may remain, the bowel being reached by an incision from the anus to the coccyx, but early and total extirpation, including the sphincter, is to be regarded as the safer method. If the peritoneal cavity is opened during the operation, use salicylic acid, instead of carbolic solution, applied to the peritoneal wound with a sponge; but as soon as the tumor is removed enlarge the external wound and close the peritoneal wound with sutures. Drainage tubes must be inserted so as effectually to remove all secretions and allow frequent cleansing by the injection of carbolic solutions; tubes may be placed between the sutures, and additional external openings may be required on either side, through which catheters may be carried to the upper part of the wound, for the purpose of cleansing with disinfectant solutions. The after-treatment must be antiseptic as to the wound, and in general

[1] G. Hauck.

[2] R. Volkmann.

such as to secure quiet of the bowels by opium; proper nutrition by easily-digested food, as milk, beef-tea, raw eggs; and perfect cleanliness of the wound externally and internally; the sutures must be removed when they become loose. The first inconvenience is from incontinence of feces, but this condition soon becomes easily tolerated, and with soft pads and bandage the patient is protected.

It is important to provide for the escape of gases after the operation. For this purpose, an egg-shaped air pessary of caoutchouc may be employed;[1] it consists of a thin, soft, India-rubber bag with a flexible tube eight inches long, ending in a stop-cock, and traversed in its long diameter by an ordinary gum catheter of full size; the bag is air-tight, and distensible at will through the tube stop-cock; when used it is introduced into the rectum after the operation and gently distended so as to reduce the area of the surrounding extra-rectal cavity to a minimum; the gases now escape freely, and the distension of the bowel greatly diminishes the internal area of the wound.

The rectum, prostate, and base of the bladder have been successfully removed for cancer,[2] as follows: A semilunar incision was made around the anus on both sides; the healthy muscular fibres of the sphincter were pushed aside, and the finger passed up to the extent of four inches, where healthy tissue was found surrounding the rectum, except in the anterior fourth, where the bladder and prostate were involved in the cancer; the adherent portion of the prostate was cut through, with the urethra contained in it; arteries were tied and the sound portion of the rectum drawn down and freed from the cancerous tissues; the healthy intestine was then attached to the skin by sutures; recovery was satisfactory.

CHAPTER XLIV.

THE ANUS.

The anus,[3] the lower opening of the alimentary canal, is a dilatable orifice, surrounded internally by the mucous membrane, and externally by the skin.

These membranes here become continuous and pass into each other; the lower end of the rectum and the margin of the anus are embraced by the following muscles: the internal sphincter, the levators ani, the coccygeal, and the external sphincter.

Exploration of the anus is made as follows:[1] Place the patient in a good light, with the body flexed and resting on the elbows and the knees; by separating the buttocks, and gently forcing asunder the margins of the anal orifice with the thumbs, a good view of the radiating plaits and of the festooned line of junction of skin and mucous membrane may be had, and possibly of the lower margin of an irritable ulcer; by urging the patient gently and repeatedly to bear down, a hemorrhoidal tumor may be protruded.

Contraction of the anus may be due to a congenital narrowing of the lower part of the rectum and the anus, or of the anal orifice alone, or the integument may extend partially over the anus; the situation and form of the anus are generally normal, but the orifice is puckered or plicated; the narrowing may be slight, or only admit the passage of a probe. The symptoms are absence of meconium, and progressive, painful tension of the abdomen, and vomiting. Contraction may also result from operations, injuries, syphilitic sores. The treatment is dilatation: Select a graduated bougie, the tip of which readily passes the contraction; inject a little oil to lubricate the parts; or, if there are feces in the rectum, move the bowels first with an enema; place the patient on the back with the thighs well flexed; warm and oil the bougie, and pass it gently but firmly into the constriction; repeat the operation, daily, until the part is enlarged to at least its normal calibre; the finger may be substituted for the bougie when the stricture is sufficiently dilated.

---

[1] W. H. Van Buren.

[2] Von Nussbaum.

[3] Quain's Anat.

If the narrowing is extreme, and very rigid and unyielding, incise the lateral surfaces on a director, and in the direction of the tuber ischii, to such a depth as to allow the passage of the feces; if the first incisions are not sufficiently deep repeat them; but it is necessary to divide only slightly or partially the sphincter. If the narrowing is due to extension of the integument, incise it in several places on the director, and dilate daily with a bougie or with the little finger.

Imperforate anus is generally caused by a lamina of fibro-cellular tissue, usually thin and transparent, permitting the meconium to be seen through it, and forming a small, roundish prominence, which is most distinct when the child cries or strains; the bulging membrane gives to the finger a doughy feeling and sense of obscure fluctuation; on pressure, it recedes, but reappears on removal of the finger; the membrane may be very thick and dense, especially at the circumference, when the protrusion will be less prominent.[1] The nature of the affection is apparent on inspection. If the membrane is thin, incise it at once; if it is thick, and there is a doubt as to the continuation of the rectum, delay a day or two for the rectum to become distended; then, while the child is held on its back, on the knees of an assistant, the thighs strongly flexed, make a crucial incision through the membrane, the point of intersection of the incisions being the centre of the anus; remove the intervening flaps with scissors, and dilate the opening daily with the finger or a bougie.[1]

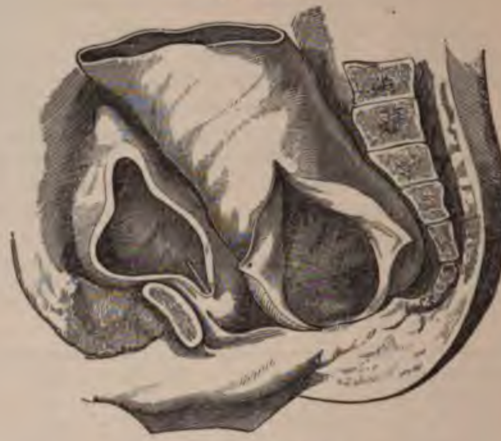
Absence of the anus (Fig. 529) is characterized by the obliteration of every trace of the orifice, the perineal raphe extending from the scrotum to the point of the coccyx without interruption, and the space of the anus being occupied with cellulo-fibrous tissue; there are no external signs by which the location, or even existence of the rectum, can certainly be ascertained; if it is present, and near the perineum, fluctuation may sometimes be detected by the finger in the perineum, or by pushing firmly up in the direction of the rectum, while with the left hand firm pressure is made upon the anterior walls of the abdomen inward and downward towards the finger in the perineum.[2] If by these manipulations the presence of the rectum is detected, an operation will afford the desired relief. The patient being held by the assistant, as before described, and, if necessary, the

---

[1] T. J. Ashton.

[2] W. Bodenhamer.

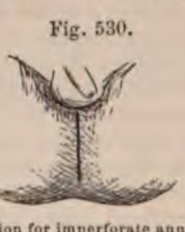
Fig. 529.



Imperforate anus.

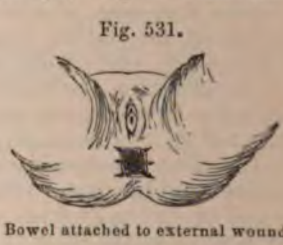
sound introduced, make an incision in the median line from a point near the scrotum to the extremity of the coccyx (Fig. 530), through the skin and superficial fascia; repeat the incision, but of gradually diminishing length, carefully feeling before each stroke, to ascertain by fluctuation the presence of the blind sac of the rectum, and also the position of the bladder or vagina; if the rectum is not found in the middle line, search posteriorly, as the extremity is sometimes displaced from the centre; the bowel will be detected as a fluctuating tumor, more or less elastic, and of a dark-brown color; when recognized, seize it with strong-toothed forceps, or pass a needle armed

Fig. 530.



Incision for imperforate anus.

Fig. 531.



Bowel attached to external wound.

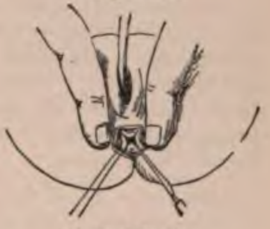
with a double ligature through it and gently draw it downwards; adhesions may be broken up with the fingers, or the knife, or scissors; when brought down to a level with the integument, open the cul-de-sac longitudinally, empty its contents, thoroughly cleanse the part, and unite the margin, by six points of suture (Fig. 531), to the integument of the corresponding edges of the perineal wound in the exact situation of the anus; the mucous membrane should overlap the external skin, to prevent the escape of fecal matters into the cellular tissue; close the wound anteriorly and posteriorly by suture; bind the child's legs together with a bandage, and apply cooling lotions to the wound; tendency to undue contraction must be counteracted by dilatation.

If it is found impossible to bring the bowel down, it must be opened by a longitudinal incision at its extremity, and allowed to remain in its position, the external opening being kept patulous by means of curved silver canulæ, in order to form that portion of the rectum absent.[1] Or, resection of the os coccygis[2] may be performed, and the rectum exposed and brought down and attached to the skin.

Abnormal anus is characterized by the existence of fistulous openings, through which fecal matters are discharged at unusual points, the normal anus being imperforate; the malformation is recognized by the absence of the anus and the escape of fecal matters from unusual outlets, as the vagina or urinary bladder. The treatment consists in establishing a more favorable outlet when the abnormal anus is a source of ill health. There are several varieties which may be the subject of an operation.

The vaginal fistula may exist either with the rectum perfectly formed, and continuous as a separate canal nearly to the anus, where it is occluded by tissues more or less thick, and having a fistulous communication with the vagina; or the rectum may terminate in a cul-de-sac opposite, or even somewhat above, the vaginal opening; the opening into the vagina varies in size and situation, being generally but a short distance up the canal, but sometimes even near the os uteri; if the opening is of small size, an operation within the first month or two is desirable; the operation is designed (1) to secure and maintain an opening into the bowel at the natural site of the anus; and (2) to close the unnatural opening into the vagina. Where the rectum continues past the vaginal opening down to, or nearly to, the site of the natural anus, introduce a curved probe into the vaginal opening and make it protrude the skin of the perineum at the proper place (Fig. 532); cut down upon the probe to the intestine; now detach and draw down the mucous membrane of the rectum, if possible, and attach by sutures to the edges of the incision, and thus secure a new anus (Fig. 531). But if the rectum, instead of being continued down to the perineum, ends in a cul-de-sac more or less high up, near the vaginal opening, dissect upward until the rectum is certainly opened and then if the mucous membrane cannot be brought down and attached to the skin, maintain the permanency of the new opening by the daily introduction of the finger; a roll of oiled linen may be introduced, but should be continued only during the first twenty-four hours; the new outlet being established, the vaginal fistula tends to close; should it remain open it must be subsequently closed by the methods employed for fistulæ of different origin.[3]

Fig. 532.



Vaginal fistula.

Or,[4] introduce into the fistula a director, and with a bistoury lay open the vagina and integuments as far back as the part where the anus should be; remove a small portion of the integuments, if necessary, and dissect down to the termination of the gut, and open it freely; the anterior boundary of the incision is the fistulous opening in the vagina, and posteriorly it would terminate where the natural outlet ought to be found; promote granulations and the cicatrizing of the original opening, and so much of the anterior portion of incision as renders the vagina incomplete; in the mean time keep the remainder open until this shall have been effected; the integuments around the incision retract and thereby obviate the necessity of removing them; the original aperture closes up with that part of the incision connected with it; the vagina becomes complete, and a route direct from the rectum is established, having no communication whatever with the vagina.

---

[1] M. Amussat; W. Bodenhamer.

[2] L. Verneuil.

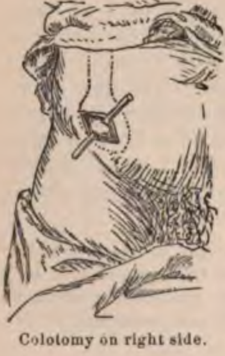
[3] J. H. Pooley.

[4] J. R. Barton.

The vesical fecal fistulæ are manifested by the thickness of the urine, its greenish appearance, its passing only at the time of urinating, and with gases; this fistula is very difficult of relief.[1] In some cases the gut terminates in the bladder, directly after its passage out of the false pelvis; again the rectum descends low down in the pelvis, even nearly to the skin of the perineum.[2] Make the usual dissection for absent rectum, and, if found, treat it as described; if the gut is not found, open the colon in the left groin, as follows:[3] The patient being placed on his back, make an incision two to three inches in length in the left iliac region, commencing on a line with the anterior superior spinous process of the left ilium and carry it in a direction parallel with Poupart's ligament; cautiously divide, on a director, the successive layers which constitute the abdominal parietes of this region; open the peritoneum and recognize the sigmoid flexure of the colon by the sacculi and transverse bands; pass a ligature through the intestine to keep it in apposition with the opening in the abdominal wall; make a longitudinal incision and give exit to the fecal matter; employ injections to cleanse the bowel above and below the opening; adhesions soon unite the intestines to the peritoneum and the anterior wound, when the lips of the wound in the intestines should be united by sutures to the edges of the external (Fig. 515) wound; the tendency to contraction must be overcome by occasional use of the dilators.

Other forms of fecal fistulæ may exist at many other points, as in the urethra, the labia majora, in the groin, and even under the scapula; if not found, the colon should be opened as above; the principles of treatment are the same in all, namely, endeavor to form an artificial anus in the proper place, the perineum, or, failing, perform colotomy at any point, even at the cæcum (Fig. 533).

Fig. 533.



Colotomy on right side.

Absence of anus and rectum is rare, and characterized by the obliteration of these parts, and the presence of a dense fibrous tissue in their normal positions; the pelvis is sometimes abnormally contracted;[4] there is no certain indication of the presence or absence of the rectum;[2] the diagnosis can be made definite only by an exploratory operation, as with a grooved needle, or by an aspirating needle, or by careful dissection. If exploration is determined upon, wait a day or more for the rectum to become distended; then insert the needle

[1] W. Bodenhamer. [2] T. Holmes. [3] M. Littré. [4] Rokitansky.

cautiously in the direction of the greatest curve of the sacrum. If incision is made, give chloroform, and require the patient to be held as for lithotomy; make an incision an inch in length on the spot where the anus ought to be; continue the dissection in the direction the rectum usually takes, not in a direct course through the axis of the pelvis, but backwards along the coccyx, the finger being used as a director, until its full length is attained, or the bowel is reached;[1] exploration should not be made with a trocar,[2] but with a small grooved needle.

Fissure of the anus appears as an ulcer, and has its origin in a crack in the mucous membrane, where it is about to assume the character of skin; it is more frequent in women, and in persons of an irritable or sensitive nervous system, and in the earlier portion of middle life, but may occur in infants.[3] The ulcer is met with at or towards the back part of the gut, and not unfrequently opposite or directly below the point of the coccyx; it may vary from the minutest point to the size of the end of the finger, and may be external, within view, or, as a narrow chap or fissure, immediately within the grasp of the external sphincter; or still higher up, as an ulceration of the mucous membrane, covering the internal muscle an inch or more from the extremity of the bowel; the external ulcer has usually a yellow or ash-colored base, but the internal one is often of a vivid red color, and in some instances the edges are undermined.[4] The predisposing causes are constriction of the anal orifice from spasmodic action of the sphincter owing to intestinal irritation produced by the ingesta or acid secretions, from cicatrization of wounds, specific ulcers, injuries, or hemorrhoids; the exciting causes are constipation, induration of fecal matter, and violent action of the expulsive muscles requisite for its evacuation.[5] The symptoms at first are experienced only at stool, when at some point there will be a smarting, stinging, or prickling sensation; later, the smarting during defecation will be increased, or become burning, or lancinating, followed by excruciating aching and throbbing, with violent spasmodic contraction of the sphincter muscle, continuing from half an hour to several hours; the stools, when solid, will be streaked with purulent discharge and slightly with blood, and when more soft, will be figured and of small size; when the disease is fully established, the pain will be induced by sneezing, coughing, micturition, forced respiration, and sitting; defecation is dreaded and postponed; highly-seasoned food and fermented liquors aggravate the symptoms; the pain often extends to other parts, and the urinary organs become deranged.[5]

In a small proportion of cases the pain does not begin until after the lapse of some time, ten minutes to two hours after the act of defecation.[4] Severe pain in this disease is due to the pinching and kneading inflicted upon the sensitive sore by the successive and unremitting contractions of the fasciculi of ultimate muscular fibres upon which it is immediately situated.[3] The examination is generally attended with much pain, and it is often advisable to administer an anæsthetic; if the ulcer cannot be exposed on separating the parts, the speculum must be used, or the finger may detect its position and extent.[5]

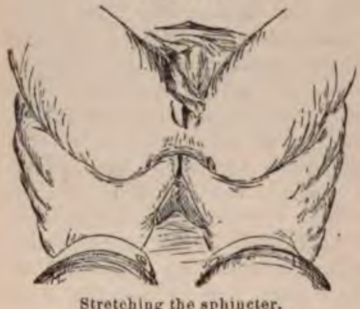
[1] B. Bell. [2] T. Holmes. [3] W. H. Van Buren.
[4] R. Quain. [5] T. J. Ashton.

Begin treatment[1] by a laxative every night, so that two passages can be secured daily; 2, if defecation is very painful, give an enema in the morning and secure an evacuation before making any application to the fissure; 3, touch the fissure thoroughly each day with a solution of nitrate of silver, varying from five to fifteen grains to the ounce, gently but thoroughly with a camel's-hair pencil; 4, if this fail, try insufflation of calomel, bismuth, or iodoform in dry powder; or lay a piece of very soft and fine lint in the sore and change daily.

The older methods of treatment were incision and forcible dilatation of the sphincter.

Incision of the ulcer is as follows:[2] The bowels having been cleared by castor oil or an injection, introduce the index finger of the left hand, along which pass a probe-pointed, straight bistoury, flatwise, to the upper extremity of the fissure, turn the edge to the ulcer, and make an incision down to healthy tissue the entire length of the ulcer, the incisions generally divide only the mucous membrane,[3] or the more superficial muscular fibres of the sphincter.[4] If this incision fail, the sphincter must be well divided, but only laterally, for anteriorly the wound might paralyze the sphincter vaginæ in women,[5] and injure the bulb in men, and posteriorly split and separate the fibres of the external sphincter only and be difficult to heal.

Fig. 534.

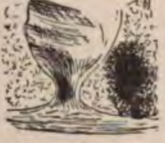


Stretching the sphincter.

Forcible dilatation of the sphincter causes atony of the muscular tissue, and thus interrupts for a few days that constant motion which prevents the healing of the fissure; it may be most readily accomplished by introducing both thumbs (Fig. 534) well beyond the external sphincter, back to back, then taking a purchase from the buttocks, with the outspread fingers carry the thumbs forcibly apart until the palmar surfaces are arrested by the ischial tuberosities; this act must be performed thoroughly and with about all the strength the surgeon can exert; some of the muscular fibres are generally torn across and the membrane lining the orifice is somewhat abraded or lacerated, but no harm results.[7] Instruments have been devised for making forcible dilatation but they are not preferable to the hands.

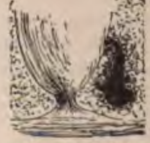
Fistula in ano is a sinus leading into the cavity of an unhealed abscess near the rectum, either from the external part, external fistula (Fig. 535), or from the cavity of the rectum, internal fistula (Fig. 536), or from both, the sinus being continuous through the abscess to the

Fig. 535.



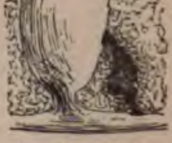
External fistula.

Fig. 536.



Internal fistula.

Fig. 537.



Complete fistula.

---

[1] C. B. Kelsey. [2] T. B. Curling. [3] R. Quain. [4] T. Bryant.
[5] Sir B. Brodie. [6] T. J. Ashton. [7] W. H. Van Buren.

external part, complete fistula (Fig. 537). The external and internal openings differ according to the duration of the disease, being prominent, hard, and round in phthisical patients, and in others so small as to escape notice. Generally there is but one internal opening, and that is within five or six lines of the margin of the anus, but not unfrequently there are several external openings.[1] In every case of suspected fistula, a careful examination should be made as follows: The patient lying on a table or bed, with the thighs flexed and the buttocks projecting, search for the opening, if it is not evident, by pressing the side of the anus with the finger; a small quantity of pus will ooze from the fistula when it is pressed upon; now introduce the forefinger, well oiled, into the rectum, which may detect the orifice of the fistula as a small depression on a teat-like elevation; insert a probe, slightly curved, into the external opening, and carry it gently on, varying the position of the point of the probe according to the resistance it meets, but using no force until it emerges at the internal opening, or is felt beneath the mucous membrane. The treatment should be dissection of the lining membrane, and complete closure of the cavity by sutures, as follows: The patient should be prepared by fasting, clearing the bowels with oil one day in advance, and opium on the night before the operation. The anæsthetic having been given, wash the parts with soap and water, shave cleanly all hairs, and irrigate with bichloride solution. Place the patient recumbent, with the knees well drawn upwards, on the side corresponding with the fistula. Wash out the rectum with bichloride solution, and introduce a carbolized sponge. Pass a director through the fistula and incise it throughout its entire extent, laying the cavity of the abscess freely open, so that every recess is accessible. Pass a thread through each flap with which an assistant keeps the wound as widely apart as possible. With toothed forceps raise the dense lining membrane and with knife or scissors dissect every portion off of the fistula and cavity; this can only be done in small sections at a time, but every particle should be removed. Apply a drain tube at the lowest part. Introduce the index finger of the left hand into the rectum, and hook down the wound so that it is quite external. First close the wound of the mucous membrane by applying the suture so that the deeper parts of the wound are brought into contact. This is effected by passing a double suture through the deeper parts of the flap from side to side like the cobbler's stitch. A second continuous suture must be applied along the margin to approximate the edges. When this part is closed, the deeper portions are surrounded by three or four sutures of strong thread or wire passed completely under the cavity by means of a strong curved needle in a handle; place a roll of carbolized gauze, of the size of the thumb, along the line of the incision, and tie the deep sutures over it, when the yielding tissues readily close the entire cavity. The sponge is now removed from the anus and iodoform dressings applied. The patient must maintain the recumbent position for a week, with a milk diet, and opium to quiet the bowels; the dressings being changed only to remove the drain tube. The sutures should then be removed, and a large warm-water enema given; the patient may now move about. Usually it is well to support the wound for several days with rubber adhesive plaster; the bowels should be daily moved by an enema.

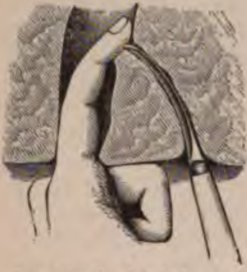
---

[1] T. J. Ashton.

The older methods of cure were by incision and granulation, and by the ligature as follows:—

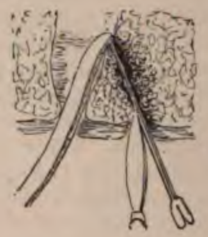
Clear the bowels with castor oil; an anæsthetic having been administered, place the patient on the side or back, with the thighs flexed; introduce the index finger of the right or left hand into the rectum, according to the side on which the fistula exists; explore the sinus again with the probe, to determine its peculiarities; now pass a probe-pointed bistoury along the course of the fistula until it emerges through the internal opening, where it should be received upon the end of the finger (Fig. 538); with a sawing motion of the bistoury divide the intervening tissues, and bring the finger and knife out together; if there is difficulty in passing the bistoury introduce a director to guide the bistoury (Fig. 539), or, before incision bring the end of the director out of the anus on the finger, and then incise the included tissues (Fig. 540); if the internal opening is not readily found, puncture the bowel at a point just above the sphincter;[1] when more than one external opening exists, lay them all open at the time of the operation,[2] but make only a single division of the sphincter;[3] but it may be advisable in persons of feeble nutrition to open the external sinuses and secure their union before completing the operation.[1] If there is hemorrhage, tie any artery that can be seized; if bleeding is severe, apply graduated compresses, or ice; then insert strips of lint to the incisions and press them firmly to the bottom of each wound; maintain them in position by a T-bandage; repeat the dressings only for cleanliness, but always force the lint to the bottom of the wound, without, however, breaking down the granulations.

Fig. 538.



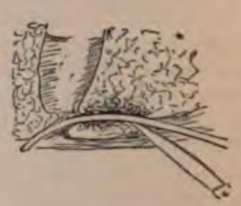
Operation for fistula in ano.

Fig. 539.



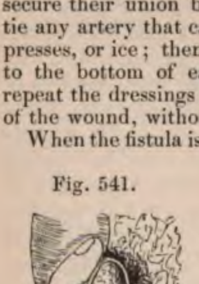
Incising fistula.

Fig. 540.



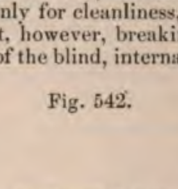
Director brought out of anus.

Fig. 541.



Application of ligature.

Fig. 542.



Tying ligature.

When the fistula is of the blind, internal form, find the opening into the rectum by exposing the cavity with the speculum and making external pressure, which forces pus through the opening; now curve a probe so sharply that it can be introduced into this opening and carried down to the bottom of the abscess, beneath the integument; cut upon the probe, and thus render the sinus complete (Fig 541), and treat it accordingly.[2]

Other methods are the ligature (Fig. 542), galvano-cautery, and écraseur, which are to be preferred

[1] W. H. Van Buren. [2] T. J. Ashton. [3] T. Bryant.

only when the incision is dangerous, as in bleeders, or is refused, or in very deep and extensive sinuses. The ligature may be silk, or elastic thread, the latter being now preferred.[1] If silk is used, select twist the thickness of common twine, and insert by means of a very slender silver probe, and secure the ends over a small button having two holes at opposite points, and tighten every second or third day until they cut their way out.[2] If elastic ligature is used, pass an eyed probe through the fistula, and bring it out at the anus; then insert into the eye an elastic thread, the size of a quill, and draw it through the sinus, tighten it and tie two or three knots.[3] The galvano-caustic wire is very easily inserted along the groove of the director; it should be raised to a dull-red heat. The écraseur is passed through the sinus by means of the probe with a thread attached to its eye.

CHAPTER XLV.

THE LIVER; GALL-BLADDER; THE PANCREAS; THE SPLEEN.

THE liver, pancreas, and spleen are classified as accessory organs of digestion.

I. THE LIVER.

The liver[4] lies under the right hypochondrium and passes across the middle line more or less into the left; the extent to which it can be felt below the edges of the ribs depends upon whether it is enlarged or not, and upon the amount of flatus in the stomach and intestines.

As a rule, in health, its lower border projects about half an inch below the costal cartilages, and can be felt moving up and down with the action of the diaphragm, but it requires an educated hand to feel it; that part which crosses the middle line below the ensiform cartilage is much more accessible to the feel, lying behind the linea alba nearly half way down to the umbilicus, and hence this is the best place to determine whether the organ is enlarged or pushed down lower than it ought to be; the fundus of the gall-bladder is situated just below the edge of the liver, about the ninth costal cartilage outside the edge of the rectus muscle, but cannot be felt.

Rupture of the liver may be limited to the convex surface, or may involve the deep portions, the concave surface, and even the vena portæ. The symptoms will depend upon the extent of the injury. Shock and pain mark the simple form, but deep rents cause collapse, vomiting, and, finally, peritonitis, jaundice, white stools, and possibly saccharine diabetes. Slight ruptures may heal, but deep lesions are very fatal owing to hemorrhage and peritonitis. Rest and opium is the proper treatment; should an abscess form, it should be opened by puncture or incision, and its cavity cleansed with weak carbolic solutions repeatedly.

Wounds of the liver may be incised or penetrating; if superficial, recovery is possible; but if deep, hemorrhage is liable to occur into the peritoneal cavity and prove fatal. If the weapon penetrates between the lower intercostal spaces the liver is probably involved; if it penetrate horizontally below the ribs, the liver may be wounded owing to enlargement, or to the dependent position of the posterior portion. A probe gently introduced may aid in the diagnosis. The symptoms are hemorrhage and shock, followed by pain, vomiting, hiccough. The wound should be cleansed with weak antiseptic solutions, a drainage-tube inserted, and antiseptic dressings applied.

---

[1] T. Holmes; T. Bryant.

[2] S. D. Gross.

[3] V. Romaine.

[4] L. Holden.

In a deep stab wound of the liver followed by hemorrhage sufficient to distend the abdominal cavity laparotomy was performed, the cavity cleansed, and the sutures of the liver wound made. The patient rallied from a state of profound collapse, remained in apparently good condition for twelve hours, and then suddenly expired. The cavity of the peritoneum was clean, the wound of the liver was perfectly closed, and no signs of peritonitis were present.

Hydatid tumor may occur in any part of the liver, but is more frequent in the right lobe; the form of the liver is variously altered; in its early stage the tumor is small, but it may develop so as to fill the greater part of the abdominal cavity and reach upward as far as the right clavicle. The cyst consists of an external, firm, fibrous capsule, of a whitish or yellowish color, adhering closely to the surrounding hepatic tissue, supplied with branches from the hepatic artery and vena portæ. The cyst is prone to undergo suppuration and atheromatous changes. It is of slow growth, and causes no other inconvenience than its weight and the effects of pressure on surrounding parts, until it excites inflammation of the peritoneum covering it. When of large size it may prove fatal by rupture, or may excite other fatal diseases, as peritonitis, pleurisy, or pneumonia. The cyst must be distinguished from hepatic abscess, distended gall-bladder, cancer, aneurism, and tumors of the kidney chiefly by its slow and insidious growth and its smooth surface; aspiration and examination of the fluid contents can alone determine its true nature; prognosis of a growing cyst is unfavorable. Treatment should be by puncture or incision. Puncture is to be preferred at an early stage, and experience shows that in a large proportion of cases the removal of the thin and limpid liquid is sufficient to destroy the parent and daughter cyst. If the tumor visibly increase, evacuation of the contents should be obtained for two reasons: first, to prevent rupture either spontaneous or traumatic; and, second, to relieve discomfort and to obviate the injurious effects of pressure.

(*a*) Puncture, without an anæsthetic or with local anæsthesia, as follows: Place the patient in a recumbent position; puncture the most prominent part of the cyst with a fine trocar and canula, connected or not with an exhausting syringe or aspirator; before the canula is withdrawn make sure that there is nothing plugging its opening and preventing the escape of some remaining fluid, by moving the end in the cyst, or passing a fine wire through it. Withdraw the canula while pressing the walls gently against the cyst to prevent the escape of fluid into the cavity of the peritoneum. Cover the puncture with absorbent cotton and collodion, a compress of cotton-wool, retained by a flannel bandage. The recumbent position must be maintained for two or three days with perfect quiet of the bowels and abdominal walls.

(*b*) Incision is necessary when the contents are largely composed of daughter cysts, or pus; the former condition is indicated by the rapid growth of the tumor, pain while it is yet small, and absence of fluctuation and thrill; the latter by chills, fever, and fluctuation. Delay in opening the cyst is now dangerous. A trocar and canula may be introduced, the latter being retained, but incision is to be preferred, and there is no need of fearing to wound a non-adherent peritoneum. Proceed as follows: The patient being in suitable position, and antiseptic cleanliness provided, make an incision through the walls of the abdomen over the most prominent part of the cyst, down to the peritoneum, arrest all bleeding; now cautiously open the peritoneum and expose the cyst wall; puncture the cyst with a trocar and canula, withdraw the fluid, taking care that none escape into the peritoneal cavity. Now make an incision into the cyst with a narrow-bladed bistoury using the canula as a guide. If adhesions have not formed between the cyst and the parietes, seize and draw forward the edges of the incision into the cyst and stitch them by continuous suture to the edges of the incision in the abdominal walls. Wash out the cavity of the cyst with a weak antiseptic solution, carbolic, salicylic, or boracic; insert a drainage-tube; apply antiseptic dressings. Daily dressings with irrigation will be required, according to the amount of discharge. No attempt should be made to tear out the parent cyst on account of danger of hemorrhage.

Serous cysts occur either under the peritoneum or in the substance of the liver; they may be single or multiple, simple or multilocular, and may attain great size, encroaching upon surrounding organs. They can be diagnosed from hydatid cysts only by their contents. The treatment is the same as hydatid cysts.

Abscess of the liver is often extremely obscure in its origin and cause, it being impossible to detect its existence by the most patient study of symptoms and careful examination of the liver.[1] There is a class of cases[2] in which abscess may exist without any local symptoms or such general disturbance of the system as is commonly regarded as indicating its presence, but associated with hypochondria and other evidence of cerebral derangement. In the more marked cases[3] the abscess is sometimes preceded by a perceptible falling-off in the general health, indicated by emaciation, dry cough and embarrassed respiration, loss of appetite, the complexion gradually assuming a muddy, sallow hue; but it more generally comes on in the midst of apparent health; the patient complains of a feeling of abdominal uneasiness, more particularly in the epigastric and hepatic regions, with some degree of fever, preceded by slight rigor or ague; but all these may be so slight as often to attract little attention. Pain[4] in the hepatic region is variable, sometimes constant, at others intermittent, or aggravated by movements of the patient, and by percussion and pressure; if the abscess is deep in the gland, very little, if any, pain will be felt; if near the surface of the organ, this pain is sharp and lancinating; it may be felt under the scapula and in the shoulder, but only in those cases where the abscess is superficial and near the convex surface; soreness or pain is found on pressure over that part of the rib nearest to the abscess; fluctuation is difficult to detect in most cases, but when present it is one of the most reliable signs of hepatic abscess. The general treatment should be quinine, acids, and such hygienic measures as will best enable the patient to withstand the suppuration.[1] In the obscure cases the abscess itself should be opened, by aspiration at the earliest possible moment, and without waiting for adhesions to form between the liver and the abdominal walls.[2]

---

[1] Frerichs.

[2] W. A. Hammond.

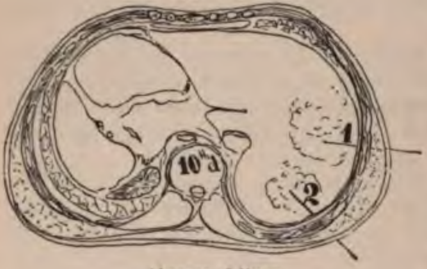
[3] Sir R. Martin.

[4] J. C. Davis.

It is laid down as a rule[3] that in all cases of hypochondria or melancholia the region of the liver should be carefully explored, and even if no fluctuation be detected or any other sign of abscess be discovered, aspiration should be performed, as it is a harmless operation; the value of this treatment is illustrated in several cases in which cerebral disorder, with melancholia, were prominent symptoms, but in which other indications of hepatic abscess did not exist: aspiration was practised successfully, pus being found in each, and recovery rapidly following.

An exploratory puncture may be safely made in the eighth or ninth intercostal space a little posterior to a line drawn vertically from the middle of the right axilla, 1 (Fig. 543). If the trocar is used, proceed as follows:[4] The presence of pus having been established by exploratory puncture or fluctuation, the patient should be directed to assume the horizontal posture near the edge of the bed, or table, with the body projecting over the side if practicable. If the patient be timid, an anæsthetic should always be used. The skin is to be drawn aside over the site of the puncture, and the trocar thrust boldly in until the cavity of the abscess is reached; on the withdrawal of the trocar the pus will sometimes spurt out, at others, slowly trickle from the canula; the drainage-tube is now introduced into the cavity of the abscess through the canula.

Fig. 543.



Abscess of liver.

It is a good plan to use a coil, or long piece of tubing, and to mark the drainage-tube at about eight inches from the end that is to be employed; the tube being in the abscess, the canula is withdrawn, and the tube cut off at the point designated. This simple procedure of dividing the tube after the canula is withdrawn will prevent the serious accident of the slipping of the drainage-tube into the cavity of the abscess.

The free extremity is now slit by a crucial incision; through the four ends threads are passed, the ends turned down and secured by adhesive strap to the skin, while the threads are each wound around strips of plaster and secured at a distance from the puncture; the abscess is now to be washed out with warm water, and then with a weak sublimate, carbolized, or iodide solution; a pad of iodoform gauze is placed over the puncture, and secured by a loose bandage; the dressing must be renewed at least twice a day, the cavity thoroughly washed and dressed as before; the utmost cleanliness should be observed in all minor details.

---

[1] J. C. Davis.

[2] W. A. Hammond; J. C. Davis.

[3] W. A. Hammond.

[4] Jiminez; J. C. Davis.

In using the aspirating trocar, the proceeding is very much simplified.[1] Treat the cavity of the abscess with the antiseptic solutions, taking the precaution of having the patient assume different positions for a minute or two at a time, in order that the fluid may come in contact with every part of the cavity; this is important in order to get any benefit from the use of these solutions; the trocar should be of five or more inches in length, and of sufficient diameter to allow of the easy passage of shreds of connective tissue.

The patient should be examined with care every day, and whenever the symptoms, such as pain, weight, or uneasiness in the hepatic region, or an increase in the volume of the liver, are noticed, the abscess must be again aspirated; if the abscess is progressing favorably toward a cure, the intervals will be lengthened, and the quantity of pus at each operation lessened; the number of times that puncture will be required is impossible to determine; an approximate idea may be formed by the quantity and character of the pus and the general condition of the patient.

When an abscess forms and presents under the margin of the cartilages, it may be evacuated by aspiration or incision; the aspirator should be used when there is doubt as to the union of the liver to the abdominal walls, but if union has taken place, an incision should be made along the margin of the cartilages of the ribs, the centre being over the most prominent point of the abscess. The cavity should be cleansed with antiseptic solutions, and free drainage should be maintained while the cavity closes and iodoform dressings used.

II. THE GALL-BLADDER.

This organ is the receptacle of the bile not required in digestion. It is located in a fossa on the under surface of the right lobe of the liver, and the large end, or fundus, projects beyond the anterior border of the gland and touches the abdominal parietes, immediately beneath the margin of the thorax, opposite the tip of the right tenth costal cartilage; the upper surface is attached to the liver while the under surface is free, and covered by peritoneum. It is between three and four inches long, about an inch and a half across at its widest part, and can contain eight to twelve fluidrachms.

Rupture of the gall-bladder, or of the biliary ducts beyond the liver-substance, is apt to be followed by speedy death from peritonitis, owing to the escape of large quantities of bile into the cavity of the peritoneum. If, however, the bile escape very slowly at first, adhesions may form, creating a cyst-like chamber where the bile accumulates; the collection may become so large and prominent as to require removal by puncture or incision. If the rupture is large, shock, collapse, and vomiting occur, followed by peritonitis. Perfect quiet secured by opiates is the only treatment. If the rupture admits of the slow escape of bile, and the formation of a cyst wall, recovery has followed the evacuation of the contents. The puncture should be made with a trocar and canula when the cyst is large, and be repeated as often as may be necessary. Laparatomy followed by suture, or removal of the gall-bladder ought in certain cases to be adopted.[1]

---

[1] J. C. Davis.

Wound of the gall-bladder is rare, and very fatal owing to the peritonitis which ensues. The operative treatment recommended has been ligature of the ducts,[2] and removal of the gall-bladder[3] by laparotomy. As the wound is almost necessarily fatal stitching up the wound in the cyst or ligation of the duct would be worthy of trial.

Gall-stones are the most common causes of obstruction of the hepatic, the cystic, and the intra-hepatic ducts. The following symptoms,[4] differentiate the locality of the obstruction, viz: 1. If in the common bile-duct there will be distended gall-bladder, enlarged liver, jaundiced skin and eyes, pipe-clay stools, saffron or black-colored urine, rigors or chills, flatulent dyspepsia, vomiting or nausea, hepatic tenderness, spasmodic pain. 2. If in the hepatic duct there will be present all of the above symptoms except the first. 3. If in the cystic duct there will be present only the following symptoms, viz., rigors or chills, flatulent dyspepsia, vomiting or nausea, hepatic tenderness, spasmodic pain. 4. If the intra-hepatic ducts are obstructed there will be of the above symptoms only vomiting or nausea, hepatic tenderness, and spasmodic pain.

For clinical purposes[5] there are two kinds of gall-stones, viz., the solitary gall-stone and the numerous gall-stones; the former is not always quite solitary but it rarely has more than one companion, but the numerous gall-stones are practically indefinite in quantity. The solitary gall-stone, when cut in two, shows that it has grown very much like a calculus in the urinary bladder by consecutive layers of deposit; it is always of fairly large size; and the number of rings which are comprised in its section show that it has been in its location for a very considerable time.

In the case of the solitary gall-stone, apparently, in a contraction more than usually vehement for the emptying of the gall-bladder, it gets lodged in the neck of the cavity so firmly that from that moment no bile passes from the hepatic duct backwards into the gall-bladder. A very frequent incident, therefore, in these cases is distension of the gall-bladder, the distension being so great as to present the appearance of a large pear-shaped tumor containing a pint, or perhaps even two pints, of opalescent mucus, never bile. In the case of numerous gall-stones, the gall-bladder is never distended, at least to anything like the extent or for the length of time in the case of the solitary gall-stone. The reason of this difference is, that in the case of numerous gall-stones they are nearly always small, although an occasional large one is found among them; their irregular size is such as to facilitate their passage through the duct, and also to permit the escape of bile along-side of them whilst they are being passed; consequently they are not lodged for any length of time in the duct, and do not prevent the flow of bile into the gall-bladder permanently, as is done by a large solitary calculus when impacted. A tumor formed by the distended gall-bladder may be discovered easily one day, and may have entirely disappeared before the next examination. The distress which the general acuteness of the symptoms causes in these cases is infinitely greater than in those solitary stones, for the patient may be found to pass small ones in large numbers, and with great frequency, each stone causing terrible agony.

---

[1] H. Morris. [2] Champaignac. [3] Herlin.
[4] G. Harley. [5] L. Tait.

An important aid to diagnosis may be found in recognition of the diagonal line, in the direction of which the gall-bladder enlarges, viz., from the normal position of the larger end near the tip of the cartilage of the tenth rib on the right side to the opposite side of the abdomen, crossing the middle line slightly below the umbilicus.[1]

Cholecystotomy is now the recognized operation for the permanent cure of gall-stones, and for all other kinds of obstruction of the gall-bladder. The most successful operator for this affection claims[2] that amongst all the many advances which abdominal surgery has seen, there is none so certain, nor so free from risk, nor so brilliantly successful as the surgical treatment of gall-stones. The following directions are given for performing this operation:[3] Having felt the position of the hepatic notch, make an incision from the margin of the ribs over it directly, or almost directly downwards, cutting carefully through the various textures until the peritoneum is reached; seize this carefully by two pairs of forceps, and pull it backwards; make an opening between the two pairs of forceps large enough to introduce the forefinger; search with it for the gall-bladder, and having found it cautiously bring its fundus towards the wound, and seize it by a pair of forceps; if it is distended it is first of all tapped and emptied; if it is not distended, or if it has been emptied, lay it open by scissors or forceps to an extent sufficient to get a finger in; then seize the edges of the wound by forceps, and secure any bleeding points; then explore the bladder, and by means of forceps or scoop remove all of the stones within. If the stone is impacted in the duct it may be broken up by strong forceps. Apply a continuous suture so as accurately to close the peritoneum by uniting the edges of the wound of the abdominal wall to the edges of the wound of the gall-bladder, the two peritoneal surfaces being carefully adapted to each other. Place an India-rubber drainage tube in the wound, and retain it for six or seven days until it is possible to remove the stitches; if stitches are removed along with the drainage tube, the wound speedily heals, and if all of the stones have been removed, the patient is already cured. If the wound re-opens and bile discharges, or mucus from the gall-bladder, the remaining stone which occludes the passage must be dealt with.

Some operators[3] stitch the gall-bladder to the wound, and delay opening it until adhesions have formed. The following points require special attention:[4] 1. No part of the wall of the gall-bladder should be cut away, else troublesome hemorrhage may ensue; 2. Great caution must be used in any attempt to dislodge stones impacted in the neck of the gall-bladder or its duct, or encysted in its walls, lest perforation should allow bile to escape into the peritoneum; 3. If the calculus is adherent to the mucous membrane of the gall-bladder, extreme care and delicacy of manipulation are necessary to avoid laceration of the cyst wall; 4. No attempt should ever be made to close up the incision in the gall-bladder so as to return the viscus to the abdomen; 5. The operation should not be too long delayed.

---

[1] J. W. Taylor.

[2] L. Tait.

[3] C. F. Maunder.

[4] H. Morris.

Cholecystectomy, excision of the gall-bladder,[1] has been performed. The incision was made as for opening the gall-bladder, but that viscus was found hypertrophied and adherent, and calculi were attached to its walls so firmly as to threaten perforation. The gall-bladder was emptied by aspiration with a syringe, the liver raised, the intestines retained by sponges, and the organ detached from its under surface. The cystic duct was ligated in two places with strong thread, and divided. The patient made a good recovery. The operation has been repeated 10 times with 8 recoveries.

Obstruction of the common duct by gall-stones has been relieved by enlarging the orignal wound for cholecystotomy with a transverse incision; this enabled the operator to pass his hand along the lower surface of the liver towards the duodenum, and thus to distinguish the presence of a hard round body; the adhesions of the colon to the lower surface of the liver were separated, when by gentle pressure and manipulation the mass was pushed back into the gall-bladder, and easily extracted through the incision into their viscus.[2]

III. THE PANCREAS.

The pancreas has been subjected to operations for the relief of diseases.

The following anatomical facts are important: The right or larger end accurately fills the curvature of the duodenum to which it is closely adherent, particularly to the descending and transverse portion of that intestine, beyond which it projects somewhat both in front and behind. The left end, or tail, reaches a higher level, and is in contact with the spleen. In front of the pancreas is the posterior wall of the sac of the omentum and the stomach. Behind it is attached the vena cava, the aorta, the superior mesentery artery and vein, the commencement of the vena portæ, and the pillars of the diaphragm. In a groove along its border runs the splenic artery and vein. The common duct passes down behind the head of the organ generally in a groove or canal. The pancreatic duct runs the entire length of the gland from left to right, nearer the lower than the upper border, until it reaches the left side of the common duct, which it accompanies to the back part of the descending duodenum, where they enter the border and terminate in a common orifice.

Rupture of the pancreas occurs in connection with serious injuries to other viscera, and cannot be separately made out and treated.

Wound of the pancreas usually involves other organs, and must be treated according to symptoms. In gunshot wounds portions of the pancreas have protruded from the wound, and been removed safely by ligature.

Cysts of the pancreas[3] result from the obliteration or obstruction of the common duct, or one or more of its branches, and they are true retention cysts, containing the physiological secretion from the distal portion of the gland tissue, with perhaps accidental products, such as altered secretions, blood, and the products of inflammation. The causes are either obstruction of the outflow of the secretion from impaction of calculi in the common duct or its branches; or partial or complete obliteration of a portion to the duct from cicatricial contraction; or sudden or gradual obstruction of the duct without diminution of its lumen from displacements of the pancreas. The size of the cyst is modified by the character and seat of the obstruction and its relative position to the secreting gland-structure. The walls are usually thin, from over-distension, in cases of rapidly-growing cysts, or much thickened when the growth of the tumor has been slow and accompanied by chronic proliferation and induration of the connective tissue.

---

[1] Langenbuch. [2] F. Lange. [3] N. Senn.

In chronic cases they may become cartilaginous or even ossified; the inner surface is either smooth, or it presents evidences of degeneration similar to those which occur on the internal surface of arteries in the later stages of endarteritis. If the pancreatic duct is obstructed at or near its proximal end, the entire duct and its branches may become dilated, presenting the appearance of varicose veins, or a more uniformly rounded cyst may form of the size of an orange, or a child's head, or even so large as to occupy the whole abdominal cavity. As the cyst increases in size, the gland structure disappears by absorption in consequence of intra-cystic pressure. It is remarkable that the cysts give rise to no serious symptoms aside from the pressure they exert upon adjacent organs. Pain is not a constant symptom, and when it is present it is due more to the causes which produce the cyst than the cyst itself. A positive diagnosis has so far not been made in a single instance. The most important points are, the history of the case, the anatomical location of the tumor, and its relations to the surrounding organs. The cases reported have occurred exclusively in adults. Sex appears to exert no determining influence. In a number of cases the clinical history alludes distinctly and forcibly to traumatism as the exciting cause.

Ascertain the existence of antecedent inflammatory affections of the organ, or in its immediate vicinity; a history of biliary or pancreatic calculi will also prove valuable in arriving at positive conclusions; rapid growth of the tumor speaks in favor of its pancreatic origin; fat in the stools may or may not exist; a pale yellow, dirty, or earthy color of the skin has been present.

The cyst, when examined early, before it has attained considerable size, is always found in the region normally occupied by the pancreas. The exact location, however, is not always uniform, as it will depend upon the portion of the pancreas from which the cyst has taken its primary origin. It may be situated below the right lobe of the liver, in the epigastric region, or in the left hypochondrium. When the tumor has attained a large size, or occupies the whole abdominal cavity, it will be difficult, and in the latter instance impossible, to determine by any known means its primary origin. In such cases it is of paramount importance to study its relations to adjacent organs. The stomach is pushed forward in all cases, and later to the right. The transverse colon is displaced downwards, the spleen to the left, and the diaphragm and contents of the chest upwards. The cyst being in direct contact with the diaphragm, it usually ascends and descends with the respiratory movements of the chest. In doubtful cases inflate the stomach and colon, with a view to ascertain their relative position to the cyst. If the patient is a female, and the tumor occupies the entire abdominal cavity, it will simulate cystic disease of the ovary so closely that a differential diagnosis between the two is impossible. The proximity of the abdominal aorta is such that the impulse of the artery is imparted to the tumor, which, however, pulsates only in one direction—away from the artery—a fact which will always distinguish it from an aneurism.

Aspiration should be limited to cysts of moderate size, and where adhesions have formed between the cyst and the anterior walls of the abdomen. In cases presenting these favorable conditions, aspiration deserves a trial, and may be repeated as often as required, or until symptoms arise which call for more radical measures. The needle should always be thoroughly disinfected by passing it through the flame of a spirit lamp, or by dipping it in a five per cent. solution of carbolic acid. Make the puncture obliquely to prevent the formation of a fistulous opening; withdraw the fluid slowly and empty the cyst as completely as possible; after the operation apply gentle pressure over the cyst by means of a compress and elastic bandage.

A pancreatic fistula may be safely and efficiently established as follows: Make an external incision four inches long over the most prominent part of the tumor and as near as possible over the seat of obstruction.

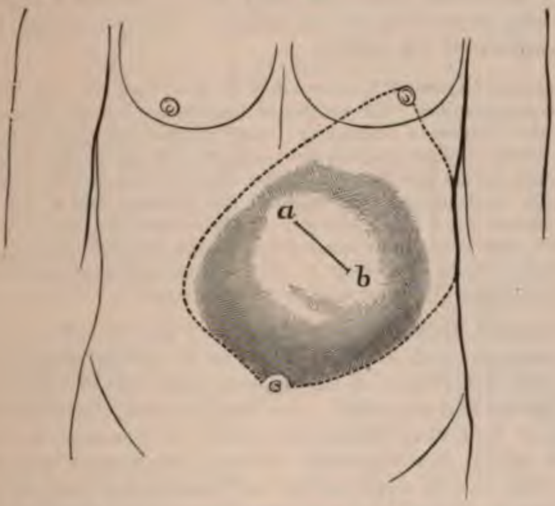
In following this rule select the places where there are most adhesions, and establish the straightest and most direct route to the primary origin of the cyst. An incision through the linea alba or parallel with the costal arch will afford the easiest access with a minimum risk of injury to important parts.

Open the peritoneum to the extent of two inches and explore; if adhesions exist between the cyst and the omentum, and the omentum and the parietal peritoneum, puncture the cyst with an exploratory needle, and, if the diagnosis is corroborated, finish the operation by incising and draining the cyst. If no adhesions are found between the omentum and peritoneum, incise the former so as to expose the cyst wall, when either of the following plans may be pursued: Stitch the parietal peritoneum to the skin with catgut; or push the margins of the omental wound back under the abdominal walls so as to expose the cyst freely, then pack the wound from the bottom with iodoform gauze, and apply an antiseptic dressing for six or eight days, until adhesions have formed between the cyst and the margins of the wound and have effectually shut off the peritoneal cavity, when the cyst may be incised and drained.

Suturing of the cyst wall to the margins of the wound as a preliminary operation should never be resorted to, as on account of thinness of the cyst walls there is danger of escape of fluid into the peritoneal cavity from the punctures made by the needle, an occurrence which the procedure was intended to obviate.

Incision of the cyst may be practised at once as follows (Fig. 544): Grasp the cyst wall with two many-toothed forceps, and draw it forward so as to bring it in accurate and close contact with the margins of the wound; remove the fluid with an aspirator or trocar with the same care as in emptying an ovarian cyst; as the cyst becomes empty pull it through the wound, which obviates any further danger of escape of fluid into the peritoneal cavity; when the cyst is nearly empty freely incise it and suture it to the peritoneal lining of the abdominal wound. The drainage tube should be fully three-quarters of an inch in diameter, and must reach from the bottom of the cyst to the surface of the wound. After emptying the cyst completely by compression, and placing the patient on his side, apply a large antiseptic dressing for the purpose of guarding against infection, and to absorb the secretions. The antiseptic dressings should not be abandoned until the peritoneal cavity has become completely closed by firm adhesions, and the size of the cyst has been reduced to a fistulous tract. The drainage tube must be shortened from time to time, as the depth of the fistulous opening is diminished by obliteration of the cyst from the bottom of the wound.

Fig. 544.



Space within the dotted lines indicates area of dulness. *a–b*, line of incision.

Extirpation of the cyst[1] has been successfully performed, the tumor having been mistaken for an ovarian cyst, but the operation is not to be preferred to that establishing a fistula.

IV. THE SPLEEN.

The spleen lies on the left side, beneath the ninth, tenth, and eleventh ribs, between two lines drawn vertically downwards, one from the anterior and the other from the posterior margins of the axilla.

Its upper edge is on a level with the spine of the ninth dorsal vertebra and its lower with the spine of the twelfth; its position and size can only be recognized in health, and very imperfectly, by a certain dulness on percussion, but it cannot be felt unless enlarged; in proportion to its enlargement, it can be detected below the tenth and eleventh ribs.[2]

Rupture of the spleen generally terminates fatally by the effusion of blood into the peritoneal cavity, but recovery occasionally occurs when the lesion is limited and the effusion slight. The symptoms are pallor, coldness, collapse, pain, difficulty of breathing, quick

[1] N. Bozeman.

[2] L. Holden.

and feeble pulse, and vomiting, and sometimes retention of urine. Rest upon the left side, and the employment of cold, externally and internally, must be relied on to arrest hemorrhage and prevent inflammation, with opium to secure relief from restlessness.

Wounds of the spleen, punctured, incised, and gunshot, are commonly complicated with severe injuries of other organs; they are frequently recovered from, especially when there is a large external opening with protrusion of the organ. The symptoms are nearly those of rupture of the spleen.

An important feature of these wounds is that they are not followed by a tendency to suppuration. Alterations of texture are limited to the immediate vicinity of the solution of continuity; there is little tendency to abundant pus formation, unless foreign matters are confined, and the bulky exudation products of inflammation are absent.[1] After shot injuries of the spleen the powerful muscular contractions seem to close the opening, and if this is not sufficient, coagulated blood fills the rest; in this manner the primary bleeding is soon arrested, and while the thrombosis advances into the injured blood-spaces of the spleen, a tissue consisting of spleen-tissue and blood-thrombi fills the shot channel, and finally forms a deep retracted scar.[2]

The treatment depends upon the nature and extent of the wound; if slight, rest and cold must be relied on to control the hemorrhage; if large, with protrusion of the spleen-tissue, the protruding portion must be ligated and cut away; this excision may be safely carried to the extent of removing the entire spleen, if damaged by the projectile. The spleen is withdrawn through the wound and a ligature applied to the vessels at the hilum; or laparotomy may be performed by extending the wound along the margins of the cartilages of the ribs.

Hypertrophy of the spleen may result from lukæmia, cystic degeneration, and other causes, and the organ often attains enormous dimensions. The diagnosis must be made by exclusion. The only remedial measure is extirpation, splenectomy. Although extirpation is very successful in wounds with protrusion, yet, when removed for disease, the operation has proved very fatal.

Splenotomy, incision, and splenectomy, extirpation of the spleen, may be performed by a median or lateral incision; if the tumor is very large the median incision is to be preferred, but if small the lateral incision will meet all indications. (1) Make an incision extending from three inches above the umbilicus to within three inches of the pubes; divide the peritoneum to the same extent; raise the omentum if it covers the spleen; while the organ is raised from its position, ligate the vessels in several parts; separate the attachments of the spleen, and remove it; the cavity must be cleansed and the wound closed. (2) Make an incision commencing below the ribs at a point corresponding to a line extending upwards from the anterior superior spine of the ilium, and curving downwards and forwards in front of the crest; open the peritoneum, break up adhesions, and turn the tumor out of the cavity; isolate the pedicle and tie it with a strong whipcord in four portions; tie bleeding vessels; return the pedicle to the cavity, and close the wound.

---

[1] G. A. Otis.

[2] Klebs.

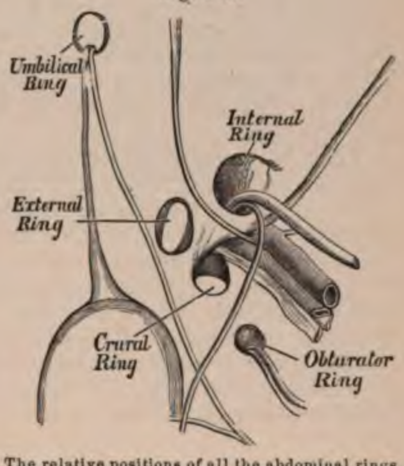
CHAPTER XLVI.

THE HERNIÆ OF THE ABDOMEN.

THE protrusion of any portion of the contents of the abdomen through an opening in its parietes is a hernia, and the varieties are named from the particular positions of their occurrence, as, umbilical, inguinal, femoral, obturator; the protruding part pushes before it the membranous structures it meets in its passage, and these furnish the coverings of the hernia.

There are five rings (Fig. 545), or naturally weak points in the abdominal walls through which the contents of the abdomen may escape, namely, the umbilical, the internal and external inguinal, crural, and the obturator.

Fig. 545.



The relative positions of all the abdominal rings from within.[1]

I. GENERAL CHARACTERS OF A HERNIA.

The sac of a hernia is the peritoneum or immediate covering of the bowel. This is always a prolongation of the parietal peritoneum from the abdominal cavity. It consists of a body, or central part, above which is the neck, and below, the fundus. At first, the peritoneum forming the neck and orifice is a plain membrane, puckered like the mouth of a closed purse, supported by the ring or canal which the hernia has traversed; next, these different peritoneal folds form adhesions together, owing to the prolonged contact of their serous surfaces; the connective and adipose tissues also seem to be transformed into a new covering, inclosing a large quantity of blood-vessels, the whole forming the induration of the neck of the sac of an old hernia, rendering it independent of the external fibrous ring; the orifice of the sac tends constantly to contract, and even become obliterated when the herniated organs cease to act upon it.[2]

The contents of a hernia consist of a part only of the abdominal viscera, and, in general, of those which are permitted by their peritoneal attachments to change their relative situations with the greatest freedom, as the small intestines and the omentum;[1] when the protruded viscera can be returned, the hernia is reducible; when they cannot, it is irreducible; if the irreducible is temporarily obstructed, it is incarcerated; if permanently obstructed, it is strangulated.

---

[1] T. Bryant.

[2] J. Birkett.

The symptoms of hernia appear in the following order: (1) There is a sense of weakness in the region in which a hernia commonly occurs; (2) fulness, especially if it is inguinal and the patient is erect; (3) a small tumor is felt, which is not permanent, but disappears under slight pressure or in the recumbent position and reappears when the pressure is removed, or in the erect position; (4) it becomes more prominent when the abdominal muscles act, or on coughing; or it may appear suddenly, as in infants, and after violent exertion in adults. The contents modify the signs thus: Intestines give a soft, yielding, elastic swelling, resonant on percussion, if filled with gas, and dull, if filled with fluid; omentum is hard, resisting, and lobulated.[1]

The diagnosis of hernia is generally very readily and correctly made if it is reducible; but when irreducible, or strangulated, the most experienced cannot always determine without the greatest care the precise nature of the complaint.[2] The most disastrous consequences have followed errors of diagnosis, and too much care cannot be taken in distinguishing hernia from other affections of the region in which it appears. The diagnosis of hernia having been made, its management requires a greater combination of accurate anatomical knowledge with skill than most other surgical affections. Conditions threatening the extinction of life occur at times and in situations demanding prompt resolution and decisive action.

II. DIFFERENT FORMS OF HERNIA.

Inguinal hernia consists in the protrusion of the abdominal viscera covered by the peritoneum, in the course of the inguinal canal, the channel, by which the spermatic cord passes through the abdominal muscles to the testis.

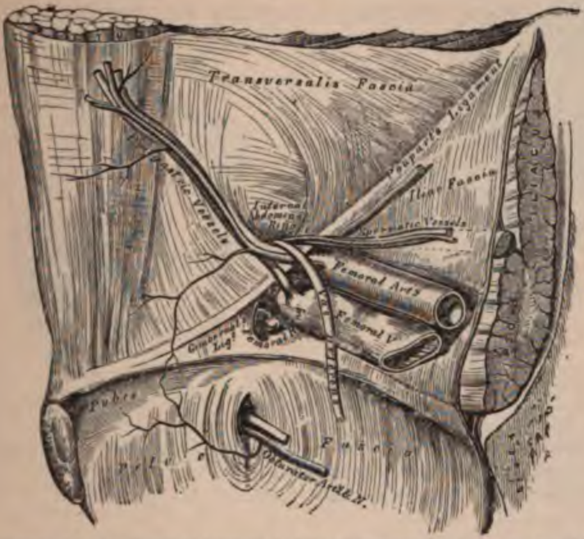
This canal (Fig. 546) begins at the abdominal ring, midway between the symphysis pubis and the anterior superior spine of the ilium, and ends at the external ring, half the distance from the internal ring to the symphysis; is two inches in length, and parallel with and immediately above the middle of Poupart's ligament; in front the canal has the aponeurosis of the external oblique muscle, in its whole length and at the outer end the fleshy part of the internal oblique; behind is the transversalis fascia, and towards the inner end also the conjoined tendon, of the two deep abdominal muscles; below it is supported by the broad surface of Poupart's ligament, which separates it from the sheath of the large bloodvessels descending to the thigh, and from the femoral canal at the inner side of these vessels; the spermatic cord, composed of arteries, veins, nerves, and excretory duct, occupies the canal, and receives from the abdominal wall, as coverings, the cremasteric muscle, the infundibuliform fascia, and spermatic fasciæ; the epigastric artery, arising from the external iliac, accompanied by two veins, ascends under cover of the transversalis fascia, along the inner side of the internal ring, close to the edge of the aperture, or

---

[1] J. Birkett.

[2] S. D. Gross.

Fig. 546.



The relations of the femoral and internal abdominal rings, seen within the abdomen. Right side.

at a short interval from it, the vessels of the spermatic cord being near, while the vas deferens, in turning from the ring into the pelvis, curves around it.

Fig. 547.

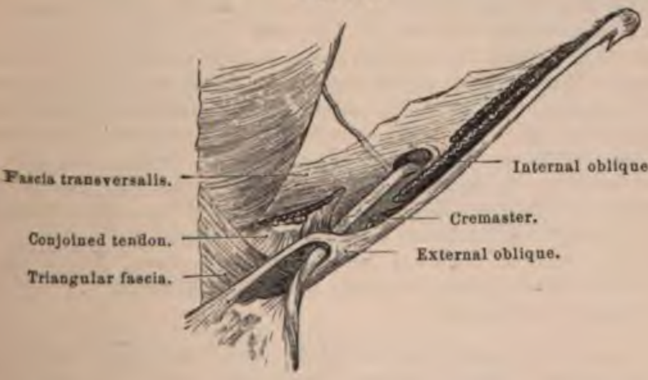
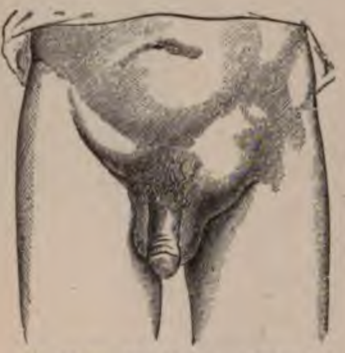


Diagram of the inguinal canal, showing its anterior and posterior boundaries.

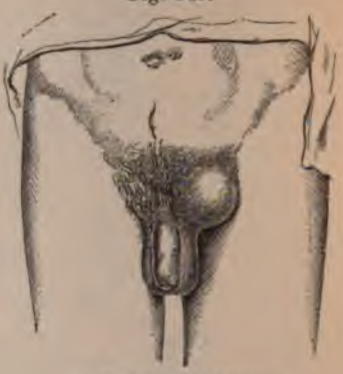
Oblique inguinal hernia is much the more frequent form. It passes through the internal ring into the inguinal canal, forming a bubonocele (Fig. 548), then emerges from the external ring and enters the scrotum; the mouth of the sac is situated to the outer side of the internal epigastric artery, and its neck and body are usually i front of the several structures composing the spermatic cord. Th

Fig. 548.



Oblique inguinal hernia. Bubonocele on right side, but passing through external ring on left.

Fig. 549.



Direct inguinal hernia.

development of the sac differs essentially in respect of the age of the individual: namely, in infancy, youth, and early manhood, the disease is usually dependent upon the persistence of a serous canal or sheath, in direct communication with the peritoneal cavity, which a portion of bowel or omentum may enter and form a hernia at any period of life; but in adult life the sac is a distinctly new formation, of slow development, and with progressive stages.

Direct inguinal hernia (Fig. 549) forms slowly, appearing first as a prominence behind the external ring, and having a more globular shape than the oblique; the finger enters the abdominal cavity more readily, and on the outer side of the orifice of the sac the internal epigastric artery is felt pulsating very distinctly; it traverses only that small portion of the inguinal canal which lies immediately behind the external ring, and pushes before it or lacerates the conjoined tendon in its passage, and the pubic portion of the internal abdominal or transversalis fascia; it is inclosed between the epigastric artery, edge of the rectus and Poupart's ligament.

Several forms of inguinal hernia are recognized, which depend chiefly upon the varying relations of the peritoneum. They have been explained as follows:—[1]

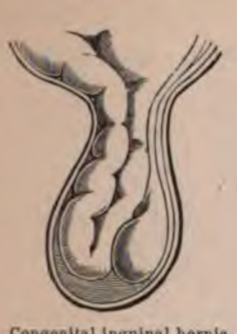
(*a*) In congenital inguinal hernia the process of peritoneum which passe down with the cord, funicular process, remains freely open; the general cavit of the peritoneum is, therefore, identical with that of the tunica vaginal testi forming the hernial sac, the bowel contained in which is in direct contact wit the testicle (Fig. 550).

(*b*) The condition of the parts in an infantile hernia are as follows: T tunica vaginalis, 1 (Fig. 551), is closed above, at or near the external inguin ring, but its funicular portion is open; the bowel in the hernial sac lies behi this funicular portion, and is represented in the diagram as having made its w

---

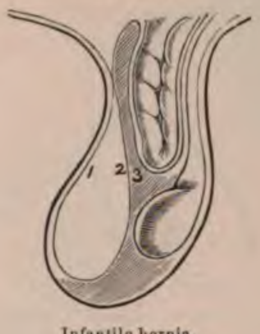
[1] T. Holmes.

Fig. 550.



Congenital inguinal hernia.

Fig. 551.



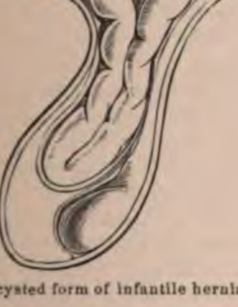
Infantile hernia.

between the funicular process and the cord; the relation of the sac to the cord seems, however, to be variable; the bowel is covered in cutting down from the skin by three layers of peritoneum, viz., 1 and 2, the opposite surfaces of the funicular process, and 3 the anterior layer of the peritoneal hernial sac.

(*c*) In the encysted form (Fig. 552) of infantile hernia, the bowel instead of passing behind the closed funicular process has distended the membrane which closes its upper end, and has pushed itself into the funicular process, the upper or back wall of which envelops it; in this case, therefore, the hernial sac is furnished by the funicular process itself, and only two layers of peritoneum cover the intestine.

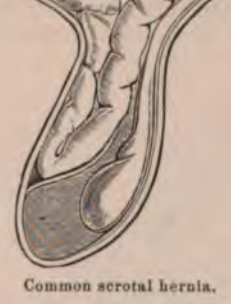
(*d*) In the common scrotal hernia (Fig. 553), the tunica vaginalis is seen behind and below, and is represented as distended with a certain amount of hydrocele fluid, but quite distinct from the hernial sac.

Fig. 552.



Encysted form of infantile hernia.

Fig. 553.

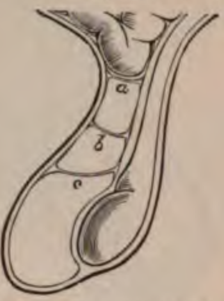


Common scrotal hernia.

(*e*) Partial obliteration of the funicular process illustrates the formation of cysts in the cord, encysted hydrocele of the cord (Fig. 554); the cavity of the tunica vaginalis testis is closed at *c*; the funicular process is also separated from the peritoneal cavity at *a*, the situation of the abdominal ring; there is also another septum at *b*. When one or more of these septa are absent or imperfect, various conditions occur.

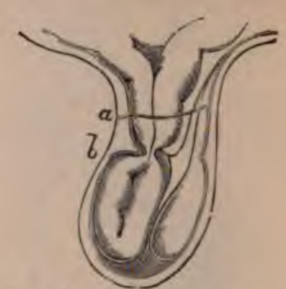
(*f*) In the formation of the hernia into the funicular process of the peritoneum (Fig. 555), the septum or obliteration at *c* is absent, so that the tunica vaginalis is open as high as the septum, *b*, which is imperfect, or has given way from some accidental cause; in the diagram the septum at the external ab-

Fig. 554.



Cysts of the cord; encysted hydrocele.

Fig. 555.



Hernia into the funicular process.

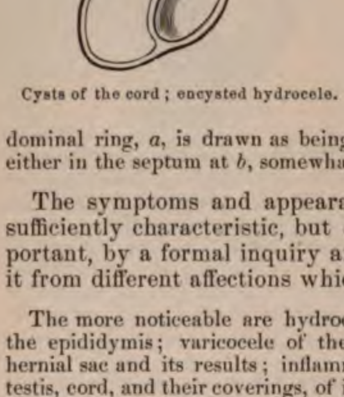
dominal ring, *a*, is drawn as being widely open, but strangulation may occur either in the septum at *b*, somewhat lower down, or at both.

The symptoms and appearances of inguinal hernia are generally sufficiently characteristic, but even in the most marked case it is important, by a formal inquiry and the recognized tests, to distinguish it from different affections which occur in these organs and tissues.

The more noticeable are hydrocele, encysted spermatocele, connected with the epididymis; varicocele of the spermatic veins; inflammation of an old hernial sac and its results; inflammatory affections and other diseases of the testis, cord, and their coverings, of inguinal and lymphatic glands; hæmatocele; malpositions of the testis; growths of fat in the connective tissue of the inguinal canal and upon the spermatic cord; diseases of the integuments of the scrotum, especially growths.

Crural hernia commences at the femoral ring (Fig. 546). First the sac is pressed downwards and slightly forwards, dilating the canal along the lymphatic compartments of the femoral sheath, pushing before it the septum crurale, and spreading out the lymphatic ducts (Fig. 556); it is then directed forwards, pushing before it the front wall of the innermost compartment of the femoral sheath and the cribriform fascia, and forming a tumor in the groin below Poupart's ligament and inside the femoral vessels (Fig. 557); it next passes outwards and a little upwards across the femoral vessels, where the fascial connections of the falciform process are weaker and looser than on the inner side, which is supported to some extent by the numerous small vessels and lymphatic ducts; finally, it lies with its fundus placed upon and above Poupart's ligament under the

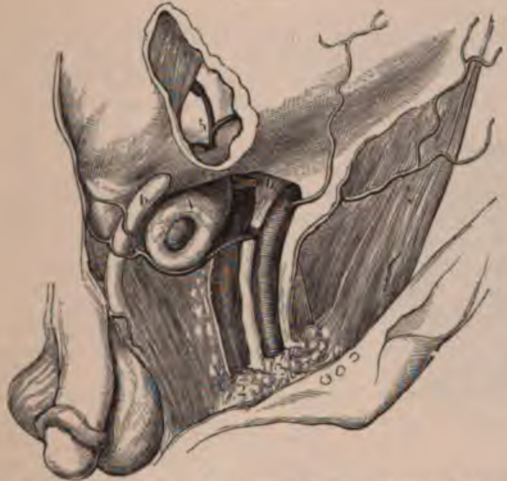
Fig. 556.



1. Femoral artery; 2. Femoral vein; 3. Innermost compartment of the sheath of the vessels into which a small hernia is protruding; 4. Saphena vein.

integuments, and its neck considerably in front of and close to the femoral vein.[1]

Fig. 557.



1. Femoral hernia; 2. Femoral vein; 3. Femoral artery giving off; 4. Common trunk of epigastric and obturator arteries; and 5. Epigastric artery; 6. Spermatic cord.

The first symptom is pain about the stomach, causing nausea on straightening the thigh, relieved on taking the recumbent position and elevating the knees; the first distinct external mark is a general swelling of the part, easily reducible by pressure, descending in the erect and ascending in the recumbent posture; next a small circumscribed tumor appears, the size of the finger's end, under the crural arch, about an inch on the outside of the tuberosity of the pubis, in the hollow between this process and the crural artery and vein. As the tumor increases in size it passes forwards, and often turns over the anterior edge of the crural arch; the swelling now increases more laterally so as to assume an oblong shape, the longest diameter being transverse; in the female it is generally very movable, and, being soft, resembles a gland; it appears in the erect and disappears in the recumbent posture, dilates when the patient coughs, is elastic and uniform when it contains intestines, and gives a gurgling noise when it returns into the abdomen; when it contains omentum the surface is less equal, it feels doughy, and gives no particular sound on reduction.[2] Femoral must be distinguished from inguinal hernia by its position below Poupart's ligament; from abscess; from an enlarged gland and an enlargement of the femoral vein; from tumors at this point.[2]

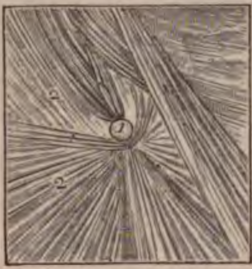
Umbilical hernia occurs at the point where the umbilical vessels pass through the abdominal wall; it exists anterior to the period when cicatrization is complete, which varies in different infants, but in general requires several months.[3] When the parts which fill the aperture are firmly cicatrized, this point of the wall is firmer than surrounding parts,[1] owing to the condensation of the cicatrix and the peculiar arrangement of the fibres of the transversalis fascia[2] (Fig. 558).

---

[1] J. Wood. [2] C. Heath. [3] W. Lawrence.

In infants the protruding viscus pushes before it that portion of the parietal peritoneum lying immediately behind the aperture in the linea alba, through which the umbilical vessels enter the abdominal cavity; the hernial sac thus formed, before the closure of the ring is effected, may pass into the connective tissue of the cord itself before that structure has separated; after the separation of the cord the hernial sac may be protruded in consequence of the umbilical aperture remaining imperfectly closed, when it is covered only by the integuments; in the youth the hernia may escape through a partially closed ring, which it dilates by continual pressure; in the adult the fibres of the linea alba may become separated by stretching, owing to the pressure within, and the hernia escape at the site of the once closed ring or in its vicinity (Fig. 558).

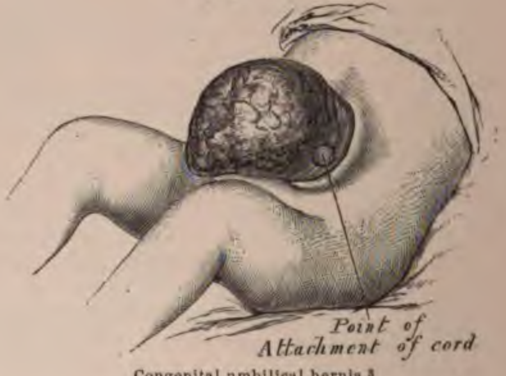
Fig. 558.



Fascia at umbilicus.

The hernia begins by forming a soft, projecting, ovoid tumor, at the navel; at first it may be reduced by pressure, when a small hole is felt with very sharp and rigid edges; if the finger is removed the skin either remains relaxed in the fossa of the navel, or it is slowly projected forwards; as the disease progresses, the protruding viscus descends lower and lower, so that the broadest part lies below the mouth of the sac; the tumor varies much in form, the transverse diameter being sometimes greater than the vertical; occasionally it is pyriform, and seems suspended, or spread out like a mushroom (Fig. 559); again, its base is nearly as large as its body; in infants the hernia usually contains intestines, but in the adult omentum is generally

Fig. 559.



Congenital umbilical hernia.[3]

---

[1] A. Scarpa. [2] Froriep. [3] T. Bryant.

added, and sometimes the stomach; the coverings, usually very thin and often inseparably united, are the integument, some fat, the internal abdominal fascia, the sac; the body of the sac is usually very delicate, but stronger near and at its orifice, around which the tissues form a firm, resisting, unyielding band; the mouth of the sac is often large, in proportion to the bulk of the protrusion.[1] This hernia has been overlooked in very corpulent persons, and proved fatal by strangulation.[2]

III. THE PALLIATIVE TREATMENT OF HERNIA.

The truss is the first appliance to be resorted to in reducible hernia; it should be applied immediately that the disposition to the formation of rupture is detected, with a view to procure adhesions of the serous surfaces; the rule applies to both sexes and all ages, the only exception being a misplaced testis;[1] the effect of such pressure is to approximate the sides of the mouth of the sac, prevent the descent of the bowel, and lead to contraction and final obliteration of the hernial sac. As the commencement of a radical cure by truss pressure dates from the last time the bowel or omentum came into the sac, it is of the first importance to prevent the hernia from ever coming down; you must not be content with seeing the patient stand when you fit a truss, but must make him sit on a low seat, then stand, walk, jump from a stool, to see if the truss completely retains the hernia; about fifteen to twenty per cent. may be cured by judicious and persistent truss-pressure.[3]

In selecting a truss the following principles should be borne in mind:[3] The practice of rendering easier the adaptation of the truss and aiding the pad to keep its place by making it so conical as to press into the hernial opening like a cork into the neck of a bottle should be carefully avoided; such a plug from without, acting upon yielding and distensible structures, is unscientific, and instead of counteracting the dilating influence of the viscera within, is calculated to increase ultimately, instead of diminishing the size of the rupture. The constant boring movement produced by the motion of the side-spring in walking, or any other form of exercise, has invariably this effect when kept up long, as is demonstrated by the deep, pit-like depression left in the integument when the truss is removed. The investing structures are pushed into the hernial apertures, and produce the same dilating effect from without as the protruding viscera do from within. The truss-pad should have its surface as nearly flat as its adaptation to the body will permit; should be shaped according to the form and outline of the rupture, should be as large as can be conveniently worn, should press upon the wall and sides of the hernial canal quite as much as upon its centre; should be so inclined as to face a little in the direction of the hernial canal, and in corpulent patients should be so inclined as to lie flat upon the sloping integuments. Violent and extraordinary efforts in coughing or straining cannot be effectually resisted by any amount of truss-pressure which can be continuously borne by the patient, hence the truss-spring should be helped, under such circumstances, by pressure with the hand upon the pad. No contrivance which has hitherto been employed to substitute the steel side or hip-spring is effective in giving real support to the rupture in cases of inguinal or crural hernia; straps and belts are yielding and incapable of such a degree of latent resistance, when passed in a circle round the body as to be effective at the point required.

---

[1] J. Birkett.

[2] S. D. Gross.

[3] J. Wood.

Inguinal hernia[1] requires a truss pad that does not press upon, or interfere with, the circulation or other functions of the spermatic cord; not uncommonly the cord becomes jammed by the downward pressure of the truss pad upon the crest of the pubic bone below, causing pain and uneasiness along the cord and in the testicle; the latter slowly enlarges if the pressure be continued, effusion takes place in the tunica vaginalis, and a hydrocele, or a hydro-sarcocele is gradually formed; or the pressure upon the spermatic origin of the cord gives rise to varicocele. It is of great importance to protect those who, from hereditary tendency or weakness of the abdominal walls, are predisposed to rupture.

For this purpose a broad band with a suitable pad (Fig. 560) may be worn (Fig. 561). It should consist of stout elastic web, which passes round the body, and it is attached to the pad in front by metallic loops engaging studs on the pad; elastic bands pass from the body band, under the limbs, to studs upon the rupture pads. If the patient is corpulent, two pads (Fig. 562) should be used to give more extended support to the abdomen (Fig. 563).

Fig. 560.

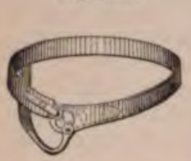
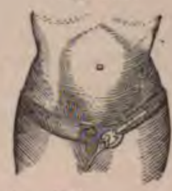


Fig. 561.



Band and pad applied.

Fig. 562.

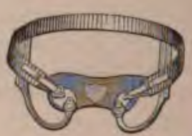
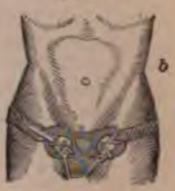


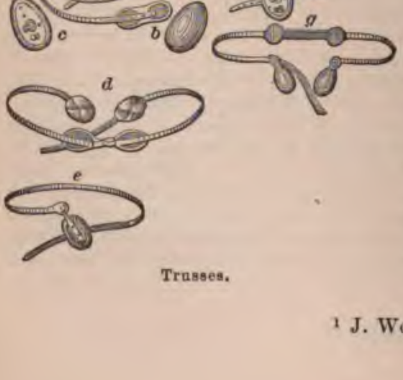
Fig. 563.



Two pads applied.

The bearing of the surface of the pad should be flat, the edge rounded off, the shape being an oblique oval. The best substance for the pad is vulcanite, and it should be maintained in position by a side-spring which encircles the body midway between the trochanter and the anterior superior iliac spine; sometimes it is necessary to wear a perineal band which buttons in front, but this may be dispensed with when the truss has accommodated itself to the shape of the body.[1] A great variety of trusses may be found, but unless they conform in construction to the principles given they will fail to meet the indications. The several instruments most worthy of consideration are (Fig. 564):—

Fig. 564.



Trusses.

a, the single truss, adapted to adults or infants; *b* is the convex pad with ball and socket attachment; *c* is a convex pad with ball and socket attachment, and set screw for giving any desired position to the pad; *d* is a double truss with broad pads for old ruptures; *e* and *f* are reversible pad single trusses, applied from ruptured side, the pads having a sliding-arm attachment secured by a set screw; *g* is a double truss of same kind.

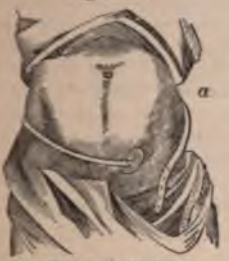
---

[1] J. Wood.

The application of the truss (Fig. 565) requires the spring to be passed across the body from the well side, and the longest diameter of the adjustable pad to be placed in the line of rupture.

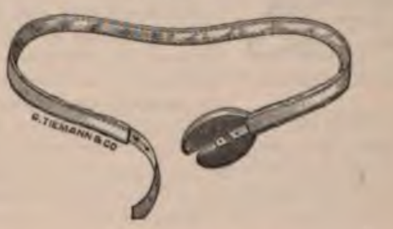
To prevent undue pressure upon the cord, which may be so great and long-continued as to cause atrophy of the testicle, a pad has been devised[1] with a slit or chink (Fig. 566), which gives a horseshoe shape, the shorter end lying upon Poupart's ligament, immediately outside and above the spine of the pubis, the longer end lying on the inner pillar; the inner border of the pad being parallel to the outer edge of the rectus muscle, while the round part presses upon the internal ring, and the movable cord slips into the chink between the two points of the pad, and escapes all injury.

Fig. 565.



Truss applied.

Fig. 566.



Horseshoe pad.

Direct inguinal hernia requires a flat, rounded, or oblately oval pad fitting closely between the edges of the rectus and Poupart's ligament, reaching well down to the crest of the pubis, and provided with a slight notch below for the passage of the cord.

Femoral hernia[1] requires that the truss pad protect the crural ring by pressure over Poupart's ligament, and also press upon and fill the saphenous opening, without pressing downward so as to obstruct the saphenous vein. The best form of truss pad is egg shape, with the small end downwards, and adapted to the shape of the saphenous opening, but rather longer, so as to press upon Poupart's ligament with its broad end above; the side spring is exactly in the centre; the pad end of the spring is bent downward in a large curve, to permit the patient's thigh to bend freely. The irreducible hernia is best supported by a truss with a hollow pad so arranged as to receive the mass.

By a thorough search for the immediate cause of a hernia much may be accomplished in many instances, especially if the case be a recent one, as, if the cause be found to be one which may be removed, the chances of complete cure are thereby greatly enhanced; for example, if a person has recently produced a hernia by straining at stool, due to constipation, this cause must be removed at once, and then with suitable treatment, immediately applied, there is more than a mere chance of complete recovery; the same remarks apply with equal force to cases of stricture and to children suffering from congenital phimosis.[2]

Umbilical hernia,[1] if congenital, should at first be treated with a piece of lint wrapped around a penny-piece and kept on with a light flannel bandage, lightly swathing the infant's body, and kept from chafing by powdered starch.

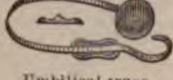
---

[1] J. Wood.

[2] W. B. De Garmo.

This form of hernia seen in the infant requires persistent efforts to close the opening by the following dressing: Apply a flat pad of any soft and tolerably firm material, moulded to the shape of the parietes, and extending beyond the margin of the opening (Fig. 567); maintain it in position by adhesive strips, or by a broad elastic band properly padded; remove the apparatus frequently to preserve cleanliness and prevent chafing, the finger being applied meantime to the opening.[1] Radical cures have been effected by the truss. In the adult this hernia is best retained by a truss with a wooden block slightly convex on its abdominal surface, and secured to an elastic spring encircling the body; if the hernia has become irreducible, apply a hollow, cup-shaped, well-padded truss. Obstruction from accumulation of stercoraceous matters frequently occurs in irreducible umbilical hernia, with severe constitutional disturbance, but without positive strangulation; this condition is best overcome by the free administration of aperient enemeta.

Fig. 567.



Umbilical truss.

IV. THE RADICAL TREATMENT OF HERNIA.

The radical treatment of hernia by operation has long been a subject of the greatest interest to surgeons. The importance of a safe and successful method of relieving the large class of every community who suffer from the life-long disability of hernia, and the constant menace of the sudden complication of a strangulation, cannot be overestimated.

The surgeon who cures hernia radically with certainty and safety, is a greater public benefactor than he who saves the life of his patient in strangulated hernia, as he not only relieves a larger number of his fellow-creatures from the suffering and inconvenience of wearing a truss, but he averts the danger of strangulation to which they are continually exposed in a greater or less degree through every period of life.[2]

Of the many different operations devised few are absolutely free from danger, and none are always ultimately successful. In determining the question of the propriety of an operation, every case must be studied by itself, and the decision should depend upon the condition of the hernia, the health of the patient, and the risk incurred. The immediate danger to life is by far the most important consideration, and the prudence of incurring this risk depends much upon the severity of the inconvenience, pain, and change endured.[3]

The following methods have attracted special attention:—

Irritation of structures external to the sac by irritating fluids injected into the tissues in and around the ring and canal for the purpose of exciting a sufficient amount of inflammation to form a barrier against the descent of the hernia, have not proven generally permanently successful. The most important operation of this class depends for its success upon the injection of a preparation of quercus alba.[4] It has been chiefly employed in inguinal herniæ, and has proved not very painful, nor very difficult to perform; does little harm, even if it does no good; will cure a certain number, and will relieve others.[1] The materials used for injection are prepared as follows: Take of fluid extract of quercus alba, prepared in vacuo, one-half an ounce; solid alcoholic extract of quercus alba, about 14 grains; triturate with gentle heat for a long time in a mortar until the solution is as perfect as possible. The operation has been slightly modified[2] and the following liquid used: R. Fl. ext. querci albæ ℥vj; alcohol (ninety per cent.) ℥iss; ether sulph. ʒij; morph. sulph. gr. iv; tinct. verat. viridis ʒij. Inject 15 to 20 drops in small and recent herniæ, but 25 to 50 drops in large or old herniæ.

---

[1] T. Holmes.

[2] Sir S. Wells.

[3] J. Wood.

[4] J. Heaton; J. W. Warren.

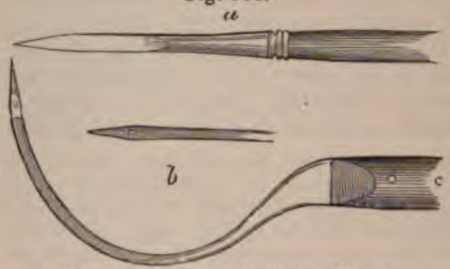
Provide an instrument somewhat resembling the ordinary subcutaneous syringe, and charge it with the fluid; invaginate the right forefinger in the scrotum and find the external abdominal ring, then with the left forefinger press perpendicularly upon the integument directly over this ring, and use sufficient force to, if possible, press the integument together with the finger directly into the ring; the left forefinger being at or in the ring, the spermatic cord and the sac, if in the way, are to be pushed to one side so that nothing may remain between the external pillar of the ring and the finger except the integument and subjacent superficial fasciæ. Keeping the left forefinger thus, take the instrument in the right hand and introduce its freshly sharpened and polished beak quickly, penetrating the integument and superficial fascia, just passing but not grazing the external pillar, and entering the canal at once; then remove the left forefinger and gently insinuate the beak further on, well into the canal, exercising the greatest care not to impinge upon the spermatic cord, which is sensitive to the slightest touch, nor upon the fibrous walls of the canal; to wound any of these parts endangers the success of the operation, and to penetrate the transversalis fascia would be particularly unfortunate. If the operator in attempting to pass through the ring should impinge upon or transfix one of the pillars, the instrument will not be freely and easily moved about. Before proceeding any further confirm the diagnosis of position by transferring the instrument to the left hand, while with the right forefinger invaginated in the scrotal tissues explore the inguinal region, and examine the exact situation of the beak. Beyond the prick of the puncture the patient suffers but little pain if the introduction is skilfully performed; any awkward movements of the beak about the spermatic cord will cause sharp pain, which is referred to the testicle or to the deeper parts of the abdomen. Having satisfied himself that the beak of his instrument is in the canal, the surgeon then deposits about ten minims of the liquid irritant, emitting it drop by drop and spreading it as much as possible; the beak of the instrument should be well swept about while delivering its contents, passing around the exterior ot the sac if unreduced and wetting all the fibrous tissues; particular care should be taken that the intercolumnar or arciform fibres and the inner edges of the external ring are wet with the irritant. A small though essential amount of the irritant should be placed in the extreme upper portion of the canal, so as to operate upon the fibres embracing the internal abdominal ring. The beak is then withdrawn quickly, the finger pressed over the puncture, a bandage with a compress, nicely adjusted, applied, and an anodyne administered. For the first few days there is sensitiveness or tenderness on pressure. The bandage is continued and the patient is not allowed to sit up or walk about until this tenderness has disappeared; after the second week the patient can generally be allowed to return to his usual avocations provided they are not laborious. The bandage is continued until worn out, or in many cases six or eight weeks.

The subcutaneous wire operation is an operation[3] which differs from others in the more complete and permanent closure of the canal which it effects by including the posterior and the anterior wall. The cases adapted to this operation are classified as follows: 1, children above five years old in whom trusses are useless and unavailable because of neglect, violent coughing and crying, sore groins, rapid increase in the size of the hernia, and interference with micturition; 2, young adults whose prospects in life are seriously impaired by the hernial condition; 3, reducible cases where the sac is thick and indurated from truss-pressure or the omentum is continually slipping down under the truss; 4, strangulated hernia, inguinal and crural, the coverings and front wall of the canal being necessarily divided to search for the constriction; 5, in irreducible hernia and large and unmanageable cases of reducible hernia, in patients otherwise in a good state of general health, not above the age of fifty, and in whom truss-pressure entirely fails to render the patient comfortable and free from danger.

---

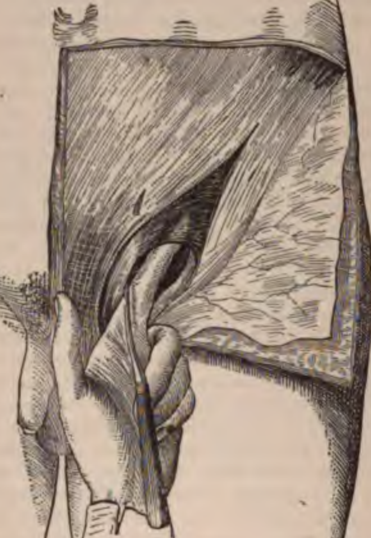
[1] G. W. Gay; W. T. Bull. [2] J. H. Warren. [3] J. Wood.

Fig. 568.



Knife and needle for radical cure of hernia.

Fig. 569.



Dissection showing the exact steps of the operation for the radical cure of hernia; first puncture; the finger is behind the edge of the internal oblique at the internal ring.[1]

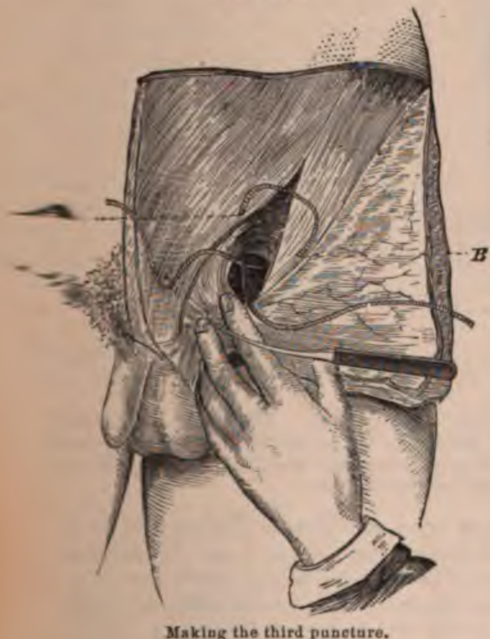
(*a*) In inguinal hernia the dangers are slight; in 200 cases not one was attended by any serious or unpleasant symptom, and the estimated successful results, in favorable cases, is 75 or 80 per cent.[1]

The operation is as follows: Provide a tenotomy knife, *a*, a semicircular needle, mounted on a stout handle, flattened at the eye, *b*, with a sharp point and blunt shoulders formed so as to slip along the front of the curved forefinger (Fig. 568), with about a foot of prepared tendon or wire, as thick as stout twine. Place the instruments in a solution of carbolic acid 1-20, and wash and shave the region of the operation. Place the patient on his back, with the shoulders raised, the knees bent, the pubes shaved, the rupture reduced, and give an anæsthetic; make an incision about an inch long in the skin of the scrotum, over the fundus of the hernial sac; carry a small tenotomy knife flatwise under the margins of the incision, so as to separate the skin from the deeper coverings of the sac to the extent of about an inch, all round; pass the forefinger into the wound and invaginate into the canal the detached fascia and fundus of the sac. The finger now feels the lower border of the internal oblique muscle, which must be lifted forwards to the surface; by this means the outer edge of the conjoined tendon is felt to the inner side of the finger (Fig. 569). Carry a stout semicircular needle, mounted in a strong handle, with a point flattened antero-posteriorly, and an eye in its point, carefully up to the point of the finger along its inner side, and transfix the conjoined tendon and the inner pillar of the external ring, when the point is seen to raise the skin, draw the latter towards the median line, and make the needle pierce it as far outwards as possible; hook into the needle a stout copper wire, silvered, about two feet long, or the tendon suture, draw it back into the scrotum, and detach; next place the finger behind the outer pillar of the ring; raise that and Poupart's ligament as much as possible from the deeper structures; pass the needle along the outer side of the finger, through Poupart's ligament a little below the internal ring (Fig. 570), and through the skin puncture made before; hook the other end of the wire to the eye, draw it back into the scrotal puncture, and detach; pinch up the sac in the wound with the finger and thumb, forcing the cord backward, and pass the needle across behind the sac (Fig. 571), entering and emerging at the opposite ends of the scrotal incision; hook the end of the inner wire on the needle and draw it back across the sac and detach; now draw down both ends of the wire until the loop is near the surface of the groin above, then twist them together down into the incision, and cut off to a convenient length. Traction on the loop invaginates the sac and scrotal fascia well up into the

---

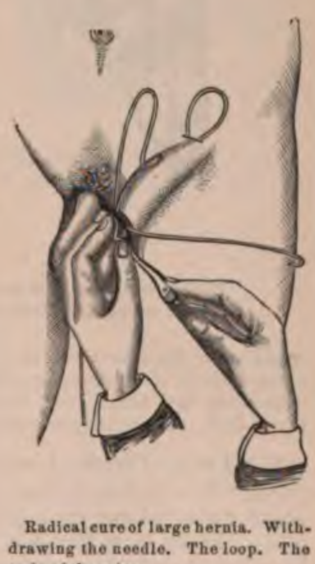
[1] J. Wood.

Fig. 570.



Making the third puncture.

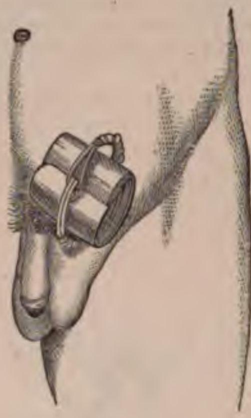
Fig. 571.



Radical cure of large hernia. Withdrawing the needle. The loop. The ends of the wire.

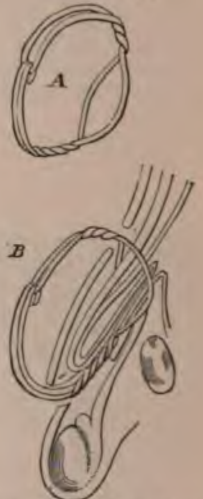
hernial canal. If tendon is used a firm knot is tied, the ends cut off close, and buried in the wound; if wire is employed, leave a loop in the upper groin puncture, twist the external ends; finally tighten the wire and twist the ends in the groin; bend the ends in the groin wound downward and those of the scrotum wound upwards, bent into the form of a hook and attached to the loop of the upper. Apply a firm pad of lint on the skin under the arch thus formed (Fig. 572), and a broad spica bandage over all. No drain or antiseptic dressing is required if wire is used, but with tendon a drain must be placed, reaching from the superficial ring to the scrotal punctures, antiseptic gauze dressings and a double spica bandage; the position of the wire and its relations to the parts are seen in *A*, *B*. (Fig. 573). The wire is ordinarily withdrawn in a week or ten days, according to the amount of action, by first untwisting the lower ends, extending to overcome the twist, cutting off the lower ends, and making traction upon the loop above.

Fig. 572.



Radical cure of inguinal hernia. Wires in place and fastened.

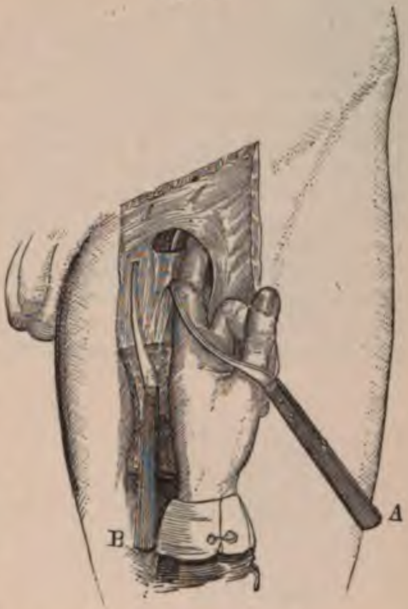
Fig. 573.



A. Wires as twisted. *B*. Vertical section showing disposition of the parts.

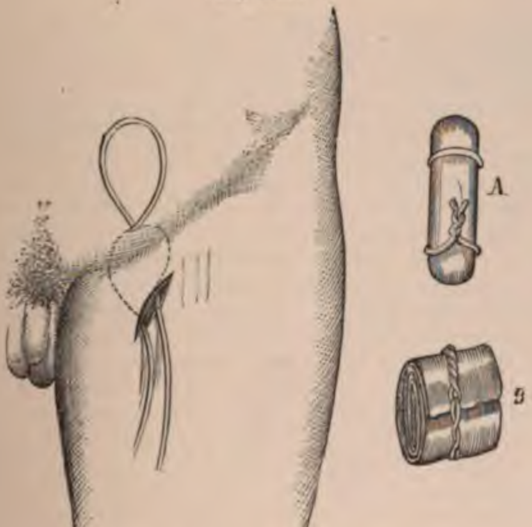
(*b*) Femoral hernia is operated upon as follows: The patient being prepared as before, reduce the rupture and make a vertical incision about an inch long through the skin over the site of the tumor (Fig. 575); detach from the skin the adjoining fascia to a sufficient extent to allow it to be invaginated fairly into the crural opening. Press the forefinger used for invaginating against the inner side of the femoral vein, and pass the needle backwards through the sac, taking up the pubic portion of fascia lata covering the pectineus muscle, reappearing in the wound, and then passing forwards and upwards through Poupart's ligament close to the nail of the invaginating finger, *A* (Fig. 574). The skin of the groin being drawn outwards by an assistant, pass the point of the needle through the wire threaded upon it, and draw it through by withdrawing the needle. Disengage the needle from the wire and pass it again through the pubic portion of the fascia lata for about an inch, the distance varying with the size of the hernial opening, on the inner side of the first puncture, *B* (Fig. 575); pass its point in the same manner through Poupart's ligament directly above and close to the curved border of Gimbernat's ligament, a portion of the fibres of which may be included; now draw the skin inwards until the needle can be pushed through the puncture previously made, and already occupied by the wire; insert the other end of the wire in the eye of the needle, drawn back through the wound, and disengaged (Fig. 575). Then twist the two ends of the wire in the incision and cut off about six inches from the twist; also twist the loop which emerges at the upper puncture firmly down into it, pressing down before it the portion of Poupart's ligament included in it opposite the crural opening.

Fig. 574.



Radical cure of femoral hernia. *A*. First passage of the needle. *B*. Second passage of the needle.

Fig. 575.

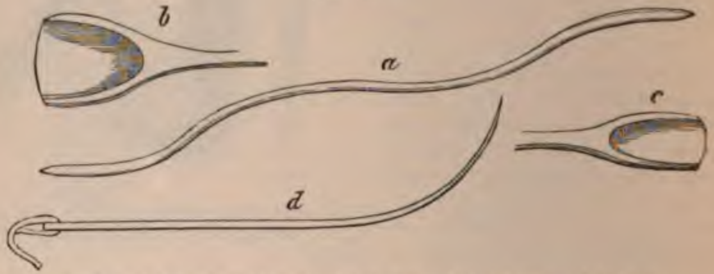


Radical cure of femoral hernia.

If the hernia is small the ends of the wire may be hooked over a pad of lint, *B* (Fig. 575), but if it is large and the ligamentous structures much relaxed, a cylindrical boxwood or glass compress, *A* (Fig. 575), should be used. Pledgets of lint placed on each side, and a spica bandage over all complete the dressing. During the operation keep the finger carefully pressed against the femoral vein so as to protect it during the passage of the needle; avoid pushing the needle too far into the abdominal cavity thus endangering the bowel, the epigastric artery, and the spermatic cord. The wire may be kept retained for the same length of time and removed in the same manner as before described for inguinal hernia.

(*c*) Umbilical hernia requires the following instruments, viz: A stout needle, well curved near the point; a small spoon-shaped director or scoop large enough to fill up the hernial opening (Fig. 576), and two pieces of stout silvered copper wire, each eight inches long.

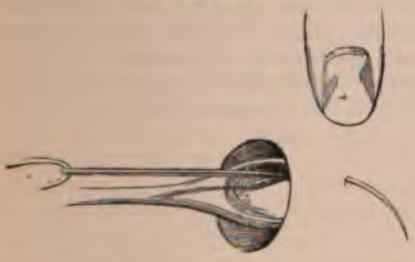
Fig. 576.



Radical cure of umbilical hernia. *a.* Director. *b, c.* Its ends. *d.* Needle.

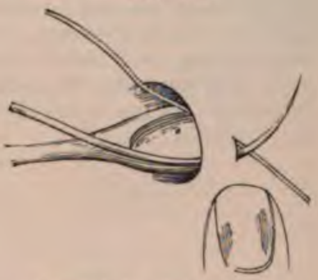
Place the patient on the back, the knees drawn up, the shoulders raised, and the hernia completely reduced. Press the convex surface of the bowl of the director into the hernial opening so as to carry the skin covering the sac quite behind the edge of the tendinous aperture on one side of the median line; the rounded end of the bowl must be pressed steadily and firmly against the under surface of the tendon, pushing the skin as far as possible along it; then place the needle, carrying one of the wires in the hollow of the director, and push the point through the tendon from behind forwards, well above the transverse diameter of the opening, the skin being at the same time drawn upward by an assistant so that it may be pierced at a lower level than the tendon is (Fig. 577). The wire having been drawn through, disengage the needle attached to the second wire, and pass it in the same way through the lower part of the tendinous border on the same side, the skin this time being drawn downward so that the needle may pass through or close to the puncture made before (Fig. 578). The second wire is then drawn through and the needle again disengaged. Repeat this proceeding upon the opposite side with the other ends of the wires, the director being placed firmly within the hernial opening, between and behind the two wires, which emerge through the skin at two points a short distance apart, in or near the vertical diameter of the opening, so as to push the skin well over to the other side of the median line behind the edge of the tendon, and make it possible to enter the needle at the same puncture at which it entered when carrying the wires in the opposite direction (Fig. 579). If the opening is very large it will be necessary to slide the point of the needle close under the skin for a short distance before piercing the tendon. The two wires are thus drawn across the opening and through its borders at equal distances above and below its centre, passing out on each side through the same puncture in the skin, and depressing the sac coverings within the area of the opening. When drawn tight they disappear into the punctures first made in the median line for the temporary purpose of their application (Fig. 580). If the hernial opening be very large a third wire may be applied in the same manner across the centre between the other two. The ends of the wires on each side are then twisted together into the punctures until the opening is felt to be closed, then cut off at a suitable distance, and hooked together over a roll of lint, the whole being retained by a strap or two of adhesive plaster and a circular bandage.

Fig. 577.



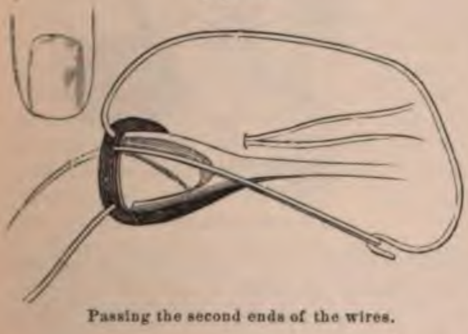
Radical cure of umbilical hernia. Passing the first wire.

Fig. 578.



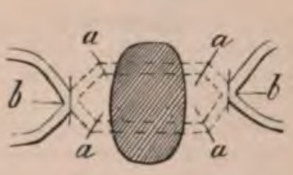
Passing the second wire.

Fig. 579.



Passing the second ends of the wires.

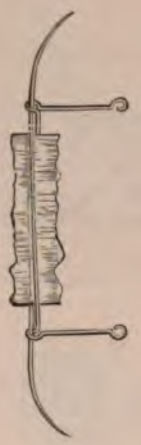
Fig. 580.



Radical cure of umbilical hernia; wires in place. *a*, *a*, *a*, *a*. Points where the wires pass through the tendon. *b*, *b*. Punctures in the skin.

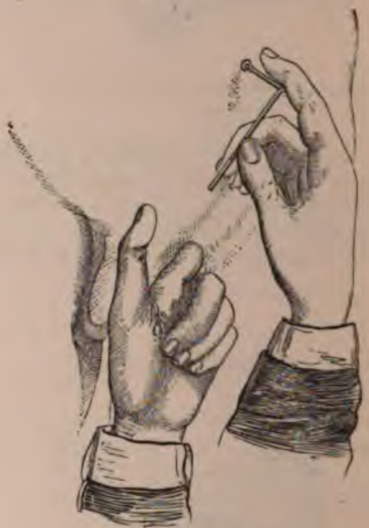
The pin operation[1] was designed for congenital hernia, and the smaller kinds of rupture in children and young boys. The pins are from three to five inches long, hard at the point and soft in the shank, so as not to break, and spear-pointed with slightly cutting edges (Fig. 581). They are applied separately in opposite directions, the point of each passed through the loop at the angle of the other, and the bent ends rotated in opposite directions, so as to twist and compress the included tissues, as follows: Place the child upon his back, thighs flexed, and hernia reduced; invaginate the scrotum into the canal, and recognize the different parts with the index or little finger passed up the canal until the border of the internal oblique can be felt in front of it.

Fig. 581.



Pins used in the pin operation for the radical cure of hernia.

Fig. 582.



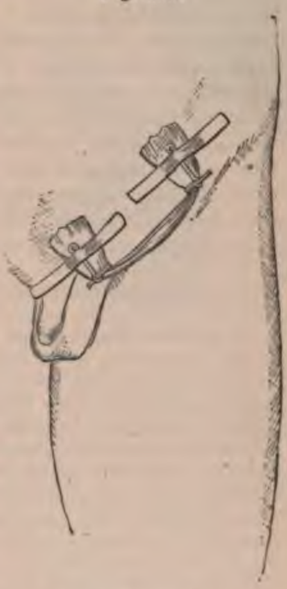
Introducing the pin.

The skin being drawn directly inwards by an assistant, pass a pin, with its concavity directed downwards, through it and the intervening tissues to the inner side of the nail of the invaginating finger (Fig. 582); slide it downwards along the side of the finger, which is, at the same time, withdrawn, until the point of the pin can be felt to touch the pubis; skirting this bone, carry it into the scrotum and bring it out through the skin over the fundus of the hernial sac, upon which the finger has been pressed. During this manœuvre, the point of the finger and the pin must move together, and the rupture must be kept up by pressing upon the internal ring with the little finger of the hand that holds the pin. Enter the second pin, with its convexity directed forwards, by the scrotal puncture through which the first pin emerged, the invaginating finger placed below it, and the scrotum again pushed up into the canal, carrying the point of the pin along until it touches the posterior surface of the outer pillar of the superficial ring. Through this it is then passed upwards and outwards, so as to raise the skin of the groin directly below the deep (internal) ring. The skin is then drawn outwards by an assistant, and it will be found that by turning the concavity of the pin inwards, its point can be brought out through, or very close to, the puncture made by the entry of the first pin. The point of each pin must then be passed into the loop of the other, which will be much facilitated by first cutting off one of them so as to make it shorter than the other. After they have been thus fastened together the point of the other pin is cut off, and the bent ends twisted around once more by simply turning over the end of the pin towards the thigh. The punctures and skin are then carefully protected by lint or plaster, the bent ends of the pins tied together or fastened down with plaster to prevent slipping (Fig. 583), and the whole bound down with a pad of lint and a spica bandage. In this operation the conjoined tendon and internal pillar are transfixed by the first pin, and the outer pillar transfixed and included by the second pin. The sac is transfixed by both pins, which lie for some distance in its interior. These parts are twisted together by turning one pin upon the other, so that the posterior wall is drawn forward and the anterior backward, and the canal is firmly closed. The cord lies between and behind the pins and is not included by them. The pins should be withdrawn about the tenth day.

---

[1] J. Wood.

Fig. 583.



The pins in place.

Removal of the sac and closure of the canal[1] under antiseptics, consists in an incision from two to three inches long through the skin and superficial fascia, reaching as far upwards as the superficial abdominal ring; the sac is then exposed by dissection, detached from its investments, lifted out, and carefully separated from the spermatic vessels and vas deferens. This is best accomplished by a free use of the fingers and one or two pairs of forceps, or by the handle of the scalpel separating the sac from its coverings by tearing. There is danger to the spermatic duct and vessels which are sometimes closely adherent to the inner surface of the sac, and covered by a dense fascia which appears to belong to or to form the sac itself. When the proper separation has been effected, and the operator has made sure of the return of the hernial contents, if reducible the sac should be drawn out of the incision and detached upwards and downwards, care being taken that the testis is not injured, which, by the attachment of the sac to the tunica vaginalis, may be drawn out; this connection having been detached, lift the fundus of the sac firmly into a vertical position. Now push up the incision of the skin until it is opposite the inguinal canal, and detach the sac from the cord as high as the deep ring. Pass the hernia needle with a handle through the neck of the sac, close to the fascia transversalis, and connect a stout catgut ligature, prepared in chromic acid, with the eye of the needle, and draw it through double; cut the loop and tie each half firmly, being careful that no bowel is included; if there is any doubt, open the sac and pass the finger within it through the deep ring. The wire is now applied to the conjoined tendon and Poupart's ligament as in the subcutaneous operation.

---

[1] J. Wood.

An internal abdominal peritoneal pad, and the restoration of the valved form of the inguinal canal,[1] is an operation devised to meet the defects of methods which apply plugs to the canal, or form a funnel-shaped puckering of the peritoneum, as in ligature of the neck of the sac. The details are as follows: Reduce the bowel and make an incision sufficient to expose the external abdominal ring; carefully separate the sac not only from the entire inguinal canal, but also from the abdominal aspects of the circumference of the internal ring, and completely reduce it into the abdomen and beyond the internal ring; with the end of the finger introduced alongside of the sac separate its attachments for about half an inch round the whole abdominal aspects of the circumference of the ring; secure a stitch firmly to the distal end of the sac, and pass the thread through the sac several times so that when it is pulled upon the sac will become folded upon itself like a curtain; thread the free end of this stitch upon a hernia needle and pass it along the finger in the canal, and through the anterior abdominal wall about an inch above the internal ring, the wound in the abdominal wall being pulled upward so as to allow the point of the needle to project through the abdominal muscles without penetrating the skin. In other cases the thread has not been passed through the sac several times, but being attached to the distal end it has been passed at once through the abdominal wall and fastened, thus drawing the sac within the cavity, the lower end being highest, and maintaining it there as a pad over the internal ring. The inguinal canal is closed by passing a single suture through the conjoined tendon, first from without inwards, and then from within outward; one end of the thread is now drawn from the eye of the needle, and held, while the needle is withdrawn, and still holding the other end of the suture, is passed through the external pillar; the thread is now taken out of the eye, and held, while the empty needle is withdrawn, threaded with the other end, and passed through the external pillar at a higher point, the thread taken from the eye, and the empty needle withdrawn and laid aside. The result is that the conjoined tendon is held by the loop of the suture, while the free ends are tied in the external pillar, thus bringing the edge of the conjointed tendon firmly under and in contact with the external pillar.

V. STRANGULATED HERNIA.

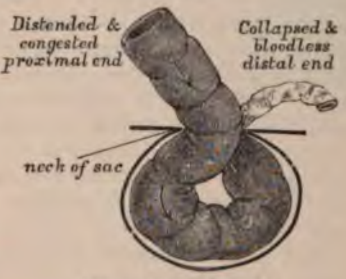
A hernia is strangulated when none of the contents of the bowel pass through and the venous circulation is interrupted (Fig. 584); the bowel involved is congested and the portion beyond the stricture is collapsed.

---

[1] W. Macewen.

The treatment of strangulated hernia is as follows: First examine to determine its kind and variety; the duration; the hour at which vomiting commenced; the variations in the composition of the fluid ejected; the usual size of the tumor; its bulk before vomiting; the changes during this stage; the pain, whether local or extending into the abdomen with or without manipulation; the condition of its coverings; its probable contents; the treatment already pursued.[1] The first step in the treatment is to endeavor to displace the hernia from its abnormal position and pass it through the orifice of the sac into the peritoneal cavity. Proceed as follows:—

Fig. 584.


Distended & congested proximal end
Collapsed & bloodless distal end
neck of sac

A strangulated hernia[2]

(1) Before vomiting occurs, abstain from manipulation of the tumor until other remedial means have been tried; place the patient on the back, with knees flexed and pelvis raised, and apply warm fomentations over the region of the mouth and neck of the sac, especially in children; support the tumor, and give a full dose of opium; if the patient cannot maintain the position, or it should be injudicious to enforce it, relax the abdominal muscles by allowing him to lie on the side, the tumor being carefully supported; if urgent symptoms do not arise, a few hours may be allowed to elapse to afford time for this treatment to take effect.

Other measures have been employed to assist in reduction, with occasional benefit, as purgative enema, which should not be repeated; reversing the trunk by keeping the head nearest the ground and the pelvis upwards; encircling the abdomen with a folded sheet and drawing the contents of the pelvic region upwards whilst the patient is in the recumbent position; hot poultices may be used, for the conditions will admit of no unnecessary delay; but the uncertain result which attends the employment of these measures, the progressive disease, the risk to life of delay, should deter from persisting in entertaining hope of reduction.

(2) During the stage of vomiting, cold may be employed over the mouth, neck, and body of the sac to retard inflammatory process, reduce nervous sensibility, and permit advantageous manipulation of the tumor; but it should be regarded only as a very useful prophylactic in cases where there is unavoidable delay in liberating the bowel from constriction. It is scarcely admissible as a rule when indications of strangulation have existed twenty-four hours, at this important moment. All other modes of treatment have now been abandoned in favor of anæsthetics which exert an influence over the causes preventing reduction more speedily, certainly with less risk to life, and much more within control. In the administration of the anæsthetic, at this stage, have a distinct understanding with the patient that if the taxis fail the operation shall be immediately performed.

---

[1] J. Birkett.

[2] T. Bryant.

The taxis must next be employed if reduction does not follow the use of the preceding measures; this is a method of manipulation and must be practised as follows: Place the patient in a position to relax all abdominal muscles which contract around the mouth of the sac; fix as far as it is possible the mouth and neck of the sac with the fingers of one hand, whilst the fundus of the tumor is held in the palm of the other, the object being to dilate the mouth of the sac and diminish the bulk of the protrusion, the fact being borne in mind that irreparable injury is frequently inflicted upon the herniated bowel by violence, and that the danger of mischief by the use of the taxis increases in proportion to the length of time the bowel has been strangulated. As soon as the voluntary muscular contraction ceases, make gentle and well-preconcerted pressure, and, if the taxis succeed, the tumor will gradually become softer or less elastic, smaller and of different shape, until it escapes from the embrace of the mouth of the sac; taxis, if not already abandoned, must always be discontinued altogether when it is certain from the vomited fluids that there is regurgitation of the contents of the duodenum and jejunum.[1]

In the effort at reduction by taxis four forms of reduction may occur without relief to the strangulation. (*a*) The reduction may be *en masse* (Fig. 585), when the herniated tumor disappears within the ring, but the bowel does not escape from the sac. (*b*) The neck of the sac is pushed back beneath the abdominal parietes with the strangulated bowel (Fig. 586). (*c*) The serous membrane of the sac is rent, burst, or torn, and the hernia makes its escape through the aperture into the subserous connective tissue (Fig. 587); the tumor becomes flaccid, the bulk diminishes as the pressure continues, but there is no jerk, and though there is but little if any swelling left, the strangulation continues. (*d*) In this form the hernia is interstitial and may be lodged between the skin and muscles, among the muscles, or between the muscles and the inter-abdominal fascia.[1]

Fig. 585.

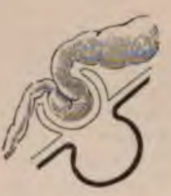


Fig. 586.

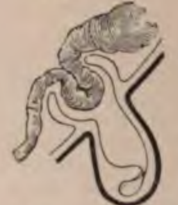


Fig. 587.

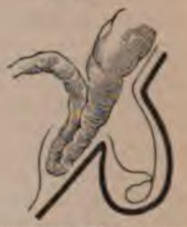


Fig. 585. Diagram illustrating the reduction of the sac of a hernia *en masse* with the strangulated intestine.

Fig. 586 illustrates the neck of the hernial sac pushed back beneath the abdominal parietes with strangulated bowel.

Fig. 587 shows the space in the subperitoneal connective tissue into which the intestine may be pushed through a rupture in the neck of the hernial sac, the intestine being still strangulated by the neck.

The failure of the taxis necessitates the liberation of the hernia, and the surgeon should be duly impressed with the indisputable fact that upon his discretion, firmness, and resolution now hangs the final issue, for each minute diminishes the chances of recovery except by a cutting operation.[2]

[1] T. Bryant.

[2] J. Birkett.

Herniotomy, kelotomy, involves, more or less, the following considerations: (1) The careful recognition of the characteristics of the tissues covering the sac, as they differ in the special regional varieties. In recent hernia the cellular tissue and fat will differ little in appearance from the ordinary condition; but in old herniæ the structures between the skin and sac are likely to be much attenuated;[1] successive layers may often be raised, sometimes to the number of fifteen or twenty.[2] The sac, in many instances, cannot easily be distinguished from the cellular tissue over it;[1] and hence the following signs are useful: If the hernia is intestinal and not adherent, a sense of fluctuation may generally be detected at the inferior part, when the tumor is grasped;[3] the sac has a bluish vesicular appearance, and if a portion is pinched up between the thumb and forefinger, the opposite surfaces may be rubbed together, which cannot be done with any other tissue; or a needle may be introduced, and if a drop of serous fluid escape this will decide the question.[4] (2) In a comparatively small number of cases, the hernia may safely be reduced by dividing the stricture external to the sac; and the question may be decided in each individual case as follows: Divide the stricture external to the sac and reduce the mass, when the symptoms of strangulation have existed but a few hours, and are not very severe, the vomiting is not stercoraceous, the patient not very prostrate, the tumor is a simple enterocele, and has resisted forcible attempts at reduction; open the sac when strangulation has existed a long time, with inability to empty the sac, persistence of stercoraceous vomiting, prostration; and after repeated, protracted, or forcible taxis has been used; or the hernia is an entero-epiplocele or an epiplocele.[5] 3. An examination of the contents of the sac to determine their condition and management. In all cases there will be more or less injection of the vessels of the protruded viscera; when the constriction has been slight, the color is nearly normal; but when severe or long continued, it may be colored purple, or of blackish hue, with here and there a slight ecchymosis, and still not be gangrenous; if there is doubt, empty the vessels by pressure, and notice whether they again fill, or apply a cloth wrung out of warm water ten or fifteen minutes, and note the change in appearance, or puncture some of its vessels to obtain a flow of blood. Notice the softness, the sensibility, and the temperature.[4] Examine the omentum present, and return it, if healthy, but if it is gangrenous, or very bulky, cut it off near the mouth of the sac, apply ligatures to vessels, and when the hemorrhage has ceased return it with its cut surface applied to the mouth of the sac and the ligatures suspended in the wound; if the omentum adhere to the sac, the adhesions may be cut through with considerable freedom, but the vessels must be carefully secured.[3] 4. Mortification of the intestine may be apparent before the operation by the pulse becoming full and soft, often intermittent with hiccup, freedom from pain, and less frequent vomiting; the tumor also becomes soft and doughy, the skin purple, the cellular tissue emphysematous and crepitant on pressure; the mortification may not be detected until the operation, when there will be a dark appearance of the fluid of the sac, a black or greenish color of the gut, a want of lustre of its coats, softening, and, perhaps, a putrid odor. If in any case it is difficult to determine at once whether there is gangrene present, divide the stricture, apply cloths wrung out of hot antiseptic solutions, and wait until there is opportunity for the circulation to be restored. If there is a very small circumscribed slough or opening, not exceeding a line in diameter, it may be surrounded by a fine catgut thread, both ends being cut short. If a large surface is involved two methods may be adopted: 1. The old procedure was as follows: Open the gangrenous portion, the ring having been divided, and return all the bowel except the part involved, which is to be retained in the wound by a fine silver wire loop; the wound is treated openly, and an artificial anus is formed which must afterwards be cured. A better method has been proposed as follows:[1] Slit open the bowel and stitch the margins to the edges of the wound, leaving the ring and surrounding parts untouched.

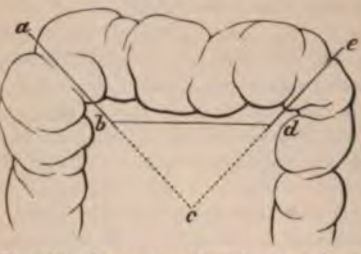
---

[1] Sir W. Fergusson. [2] F. H. Hamilton. [3] Sir A. Cooper.
[4] S. D. Gross. [5] J. Birkett.

The intestine should simply be cut into as if it were an abscess; if the gut is dead the ring will almost certainly be glued around its neck by adhesive lymph and the abdominal cavity quite shut off from the hernial sac and its contents; the result of division of the stricture is that the protecting barrier which divides the still asceptic peritoneal cavity from the putrid sac is broken down, and putridity spreads upwards into the abdomen and kills the patient by rapid septicæmic poisoning.[1]

The excision of the gangrenous bowel has been successfully performed as follows:[2] The gut was seized with hæmostatic forceps on either side of the diseased portion which was then excised to the extent of about four inches, the corresponding mesentery having first been ligated in segments with strong catgut about half an inch from its attachment; the tissue in the grasp of the forceps was also removed, and after ligating all bleeding vessels the two extremities of the gut were united with fine catgut using Lembert's suture; the cut edges of mesentery were also sutured, leaving the ligated portions lying in a fold above; especial attention was paid to prevent the entrance of fluid into the peritoneal cavity, and to keeping the protruded gut warm; all exposed parts were irrigated with warm bichloride solution, 1 to 3000, and the gut returned; the sac was ligated at its neck and cut off, a rubber drain placed in position, the wound closed, and iodoform applied over incision, and a pad of bichloride gauze externally. The section of the mesentery, *a b d e* (Fig. 588), was preferred to the V-incision, *a c e*, as it does not cut off the blood supply to the remaining gut.

Fig. 588.



Resection of gangrenous bowel. *a, c, e.* Usual section. *a, b, d, e.* Actual section.

---

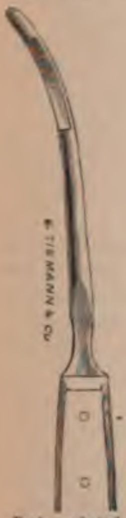
[1] W. M. Banks.

[2] J. C. Stewart.

Oblique inguinal hernia, which has resisted well-directed taxis, while the patient is fully anæsthetized, must be at once liberated by division of the stricture.

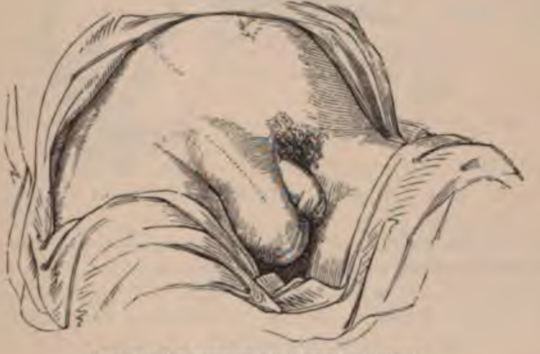
The coverings are as follows: (1) skin, (2) superficial fascia, (3) intercolumnar fascia, (4) cremaster muscle, (5) infundibuliform fascia, (6) subserous cellular tissue, (7) sac.[1] The anatomical points to be particularly sought are (1) the external ring, (2) the aponeurosis of the external oblique muscle, (3) the internal ring, (4) the mouth of the sac; and the length of the incision should be just sufficient to expose freely these anatomical parts.[2]

Fig. 589.



Probe-pointed bistoury.[3]

Fig. 590.



Incision for strangulated inguinal hernia.

This operation should be performed with careful attention to all of the details required in the use of antiseptic dressings. Provide an ordinary hernia knife (Fig. 589), a common scalpel, probe-pointed bistoury, forceps, director, carbolized sponges, carbolic water 1 to 20, bichloride solution for irrigation, and carbolized gauze. Place the patient on a firm low table; shave the parts and wash them with bichloride solution; give the anæsthetic fully; raise the shoulders, and slightly flex the thigh of the affected side, make an incision through the skin over the neck and body of the tumor, its upper extremity being nearly midway between the anterior superior spinous process of the ilium and the tuberosity of the pubes, about one inch and a half above the level of Poupart's ligament, and its lower about the middle of the scrotum (Fig. 590).[4]

Or, with the aid of an assistant, raise a fold of integument, pass a sharp-pointed bistoury through its base, and cut it outwards (Fig. 591).

This incision exposes the intercolumnar fascia which forms the first and thickest covering of the sac; divide this fascia after raising with forceps or on a director, when the cremaster muscle will be exposed, which must be cut in a similar manner, and this incision lays bare the sac (Fig. 592). The division of these layers often causes great embarrassment and delay, for the operator, expecting to see the sac itself, when he has divided the integuments, mistakes this thickened covering and the cremaster muscle for the hernial sac, and cuts the fascia with extreme caution, fibre by fibre.[1] Open the sac with exceedingly great care, to avoid including the walls of the bowel, either seizing the sac with forceps (Fig. 592), or raising it between the thumb and fingers. Make an opening sufficiently large to admit a grooved director with the scalpel, the sharp edge of which is directed laterally, the side of the blade being placed nearly flat on the tumor; divide the sac on the director, pressed firmly against its inside[2] (Fig. 593). If the intestine is connected with the sac by adhesions, an extraordinary amount of caution is required in opening the sac, as it contains little or no fluid;[1] next, pressing the finger upon the sac, insinuate it through the external inguinal ring, to ascertain if there be any structures which firmly encircle the neck and orifice of the sac outside; if any are found, introduce a grooved director underneath,

---

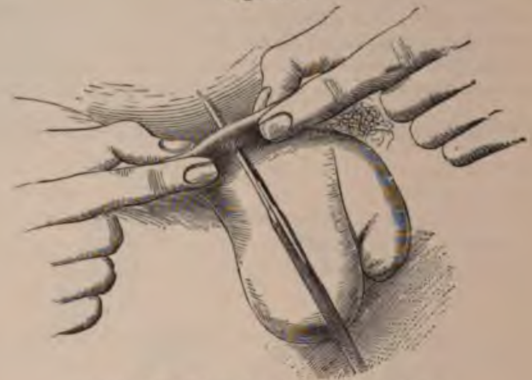
[1] H. Gray.

[2] J. Birkett.

[3] Sir A. Cooper

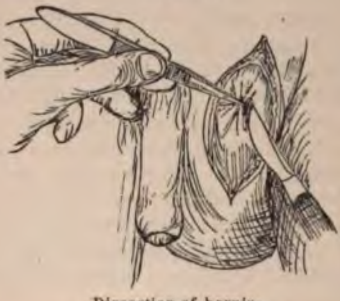
[4] Sir W. Fergusson.

Fig. 591.



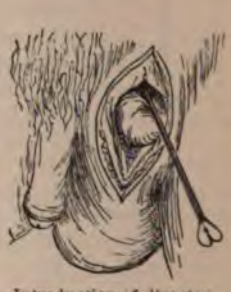
Operation for hernia; division of the skin.

Fig. 592.



Dissection of hernia.

Fig. 593.



Introduction of director.

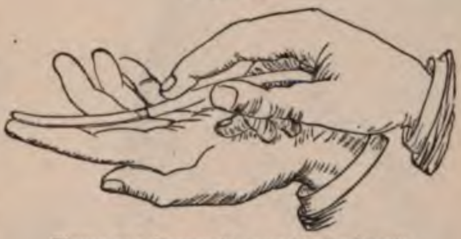
---

[1] Sir A. Cooper.

[2] J. Birkett.

and cut them; make slight pressure upon the sac to return its contents into the abdomen; if reduction be impracticable, open the sac sufficiently to reach its orifice easily; pass the index finger along the anterior surface of the protrusion upwards towards the mouth of the sac, when the stricture will be encountered; the palm being upward, pass the hernia-knife flatwise along the finger (Fig. 594), or on a grooved director, through the mouth of the sac; turn the knife so as to cut parallel with the linea alba, and divide the structures in contact with it sufficiently to allow the ungual phalanx to pass freely into the abdominal cavity.[1] Carefully examine the protruded intestine to determine whether the brown color which it assumes under strangulation lessens or disappears, the proof of a return of circulation; the intestine should also be pulled down a little to examine the part immediately compressed by the stricture; the veins on the surface may be emptied by pressure, and their sudden filling noted; if the intestine appears to have free circulation, relax the parts by position, and directly but gradually return it, replacing about an inch at a time, and securing each part with the fingers until the whole is returned into the abdomen. The contents of the hernial sac should now be returned; all violence and improper haste should be guarded against, for the intestine is tender, and will easily tear at the strictured part.[2] Clear the parts of blood, irrigate with the bichloride solution 1–5000, nicely adjust the sac and its coverings, introduce a drainage tube at the lower or upper angle, and stitch all opposing tissues together with the continuous suture.

Fig. 594.



Finger as a director in operation for hernia.

In cases where the most dependent opening would be near the sources of putrefaction it is well to have the drainage-tube in another part of the wound; thus in inguinal hernia the tube would no doubt be in the most dependent part if its orifice were close to the pubis, but as that would be much too near sources of putrefaction, such as the vagina and penis, the orifice of the tube ought to be at the outer angle of the wound (Fig. 595).

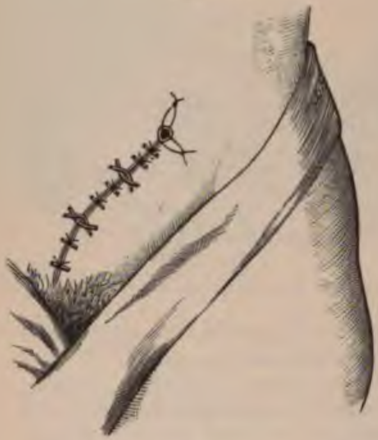
Bring the edges of the wound together with two relaxing and several coaptating interrupted sutures, or the continuous suture (Fig. 595). Dust the surface with iodoform and apply iodoform dressings with the spica bandage to retain them in position. A full antiseptic dressing after an operation for hernia includes a spica on both sides. (Fig. 596.)[3]

The important feature of the after-treatment is the diet, which should be farinaceous, with milk; opium should be used when required; the bowels are often relieved spontaneously, but if they remain inactive, and any discomfort arises, give an enema of warm water, or gruel with common salt, or a little castor oil; if thirst is distressing, give ice; stimulants are often required soon after the operation, but should be given in small quantities, and the addition of thirty drops of laudanum is frequently very useful.[1] If, instead of rapid union, the connective tissue, the wound, the omentum, or the hernial sac inflame, remove the lower suture, or all of them, to secure free drainage, and adopt the treatment for inflamed, suppurating, or sloughing wounds.[1] Thorough disinfection of the wound at all stages by bichloride solutions is most important. If the sac contain both omentum and intestine, the former will be in front, and when omentum is found search should be made to ascertain if there is not a small knuckle of intestine behind.[2]

---

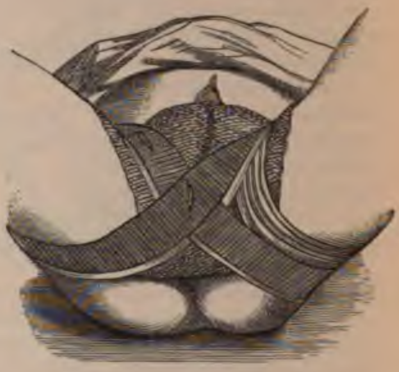
[1] J. Birkett. [2] Sir A. Cooper. [3] W. W. Cheyne.

Fig. 595.



Incision for inguinal hernia, stitched, showing the position of the drainage-tube at the outer angle of the wound.

Fig. 596.



Dressing in hernia cases or in operations on the scrotum, showing the arrangement of the bandages in the perineum, seen from below.

Omentum is much less capable of resisting the effects of inflammation than intestine, and is frequently not in a condition to be replaced when the latter is; when inflamed, the omentum is less discolored than the intestine, and loses its consistence, and if the tests applied to the intestine prove feeble circulation, the omentum should be excised; it should also be excised when much enlarged by intestinal deposits, or liable from its bulk to excite peritonitis.[3] If there are recent adhesions, carefully disengage the intestine with the finger or handle of the knife; but if they are short, and the intestine and sac are agglutinated by old adhesions of limited extent, cut off redundant portions of the sac, and return the remainder still adhering to the bowel. Adhesions at the mouth of the sac are separated with extreme difficulty; dilate the wound to the point of attachment; slit up the tendon of the external oblique; if convolutions are glued together, separate them.

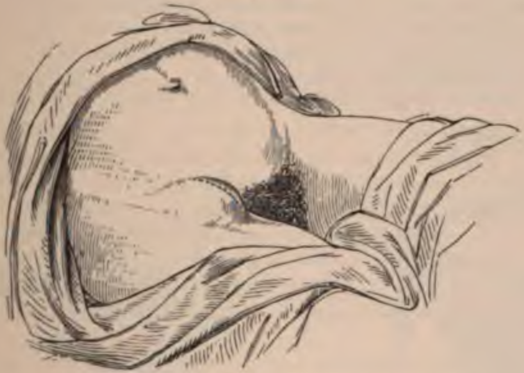
Direct inguinal hernia must be operated upon with proper caution. When the taxis is used, direct the pressure upwards and inwards, instead of upwards and outwards.[1] If an operation becomes necessary for relief, make an incision through the integuments along the middle of the tumor from its upper to its lower part; divide the fascia, which brings into view the sac; the stricture should now be sought for, and, whether found at the external ring, or higher up, or within the sac, divide it directly upwards, to avoid the epigastric artery.

---

[1] J. Birkett. [2] F. H. Hamilton. [3] S. D. Gross.

Femoral hernia, becoming strangulated, differs in this respect, from inguinal hernia, that time is of immense consequence, as mortification occasionally takes place in less than twenty-four hours from the shock. First employ taxis, as follows: Give an anæsthetic, and then place the patient on the back; elevate the head, shoulders, and pelvis; flex the legs upon the thigh, and the thighs upon the body, and rotate the affected thigh strongly inwards; draw the tumor downwards and slightly inwards, to efface the angle which it forms with the femoral canal, and bring it opposite the external ring; now push the parts directly backwards, to get them out of reach of the lunated edge of the ring; next make the pressure in an upward direction[2] If taxis fail, proceed to operate. The coverings of a femoral hernia are: skin, as follows: superficial fascia, cribriform fascia, crural sheath, the septum crurale, subserous areolar tissue, sac.[3] Select a scalpel, director, and hernia knife. The patient being placed on a suitable table, and anæsthetized, empty the bladder, and proceed as follows: Make an incision down to the superficial fascia from an inch and a half above the crural arch, in a line with the middle of the tumor, downward to its centre below the arch (Fig. 597); or make a second incision from the inner across to the outer side of the hernial tumor, so that the form of the double incision shall be somewhat crucial; divide the skin and superficial fascia, which in recent hernia is very thin and may escape notice, or in very large hernia may be inseparably united to the fascia propria, cribriform, or deep

Fig. 597.



Incision for strangulated femoral hernia.

---

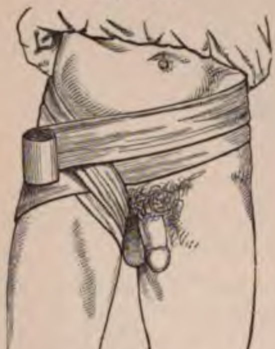
[1] Sir A. Cooper. [2] S. D. Gross. [3] H. Gray.

fascia; the latter must not be mistaken for the sac; divide this fascia longitudinally from the neck to the fundus of the sac and expose the layer of fat between the fascia propria and the sac, with the director on which the entire sac is laid open; introduce the finger gently into the sac, between the intestine and its anterior part, on which carry the hernia knife into the crural sheath; divide the sheath as far as the anterior edge of the crural arch, or Poupart's ligament, a distance not exceeding half an inch in a small hernia; if the intestines, when slightly compressed, cannot be readily emptied, the finger must be passed at least half an inch higher under the posterior edge of the crural arch and the fascia tranversalis, and the knife, carried within the stricture, must be inclined obliquely inward and upward, at right angles with the crural arch; divide the stricture in that direction sufficiently to liberate the intestine and admit of reduction. In very large herniæ it is advisable to divide the stricture external to the sac, but in small herniæ the risk of gangrene is such as to render opening the sac necessary; if the intestines adhere to the sac, separate them with great caution with the finger, or if the adhesions are short and very firm, portions of the sac must be cut away and returned into the abdomen with the intestine, to which they adhere, and the stricture must also be divided with great care, fibre by fibre. The after-treatment is the same as for other hernia.

If the omentum has adhesions, break them down with the finger, and if more has descended than can be easily returned, or if it has become hard and knotty, cut it off through the sound part, which will be known by the bleeding vessels;[1] ligate the vessels, and return the mass only to the mouth of the sac; when the protruded parts have been returned, close the wound with aseptic sutures, and apply antiseptic dressings with suitable compress; retain it there with the spica bandage (Fig. 598).

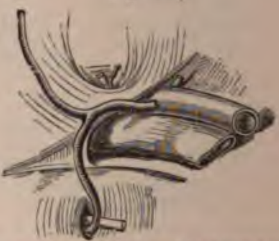
The only possible danger which can be met with in the deep incision is an abnormal distribution of the obturator artery, which, if it arise from the epigastric artery, and wind close to the inner side of the neck of the sac (Fig. 599), might be divided, and give rise to troublesome hemorrhage; as it is impossible to ascertain the presence of the vessel in that position beforehand, and as it is seldom damaged by the cautious use of the knife, its existence may be ignored in practice.[2]

Fig. 598.



Spica bandage.

Fig. 599.



Variations in origin and course of obturator artery.

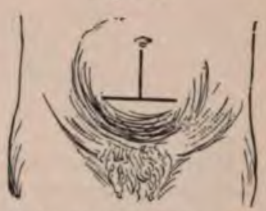
---

[1] Sir A. Cooper.

[2] C. Heath.

Umbilical hernia, strangulated, differs from other herniæ in this, that too much stress cannot be laid upon the protracted and judicious employment of taxis, owing to the great fatality of operations upon this hernia. Place the patient on the back; give an anæsthetic; as the tumor has descended, if at all bulky, draw it away from the ring, press its contents directly upwards, or upwards and backwards in a direction opposite to that of the displacement. Should the taxis fail, and the symptoms not be urgent, try the effects of a full anodyne and cold or warm applications.[1] These efforts having failed, proceed to operate antiseptically: Select a scalpel and director; bearing in mind the thinness of the external coverings, particularly in recent cases, make a ⊥-shaped incision (Fig. 600), the vertical limb being carried nearly an inch above the upper extremity of the tumor, directly in the line of the linea alba; raise successive layers on the director down to the sac, which must, if possible, be left intact, owing to the great danger of fatal peritonitis, if it is divided. Seek the seat of stricture, which is generally found at the upper margin of the ring; carry the knife upwards upon the finger, and divide the stricture to the requisite extent; draw the protruded parts somewhat downwards, to liberate them from their confinement, and gently replace them in the abdomen—first bowel and then omentum. If the constriction is within the sac, the latter must be opened, the incision being as small as possible. When the hernia is irreducible, leave the protruded structures, after the division of the stricture, in their extra-abdominal situation.[1]

Fig. 600.



Incision in operation for umbilical hernia.

Ventral herniæ are the protrusions of the intestines at points in the abdominal wall other than those already given; more frequently they are in the linea alba which seems to part during parturition; they may become of large size. They may occur at other points, as in the lineæ semilunares, the hypochondriac and iliac regions. They sometimes result from blows by which the walls are weakened. The treatment is support with a belt and well-adapted pad. If this form of hernia becomes strangulated, the operation is not unlike that for umbilical hernia.

Obturator hernia escapes through the thyroid foramen, and the neck of the sac lies behind the horizontal ramus of the pubic bone. The most characteristic symptoms are, pain along the inside of the thigh due to pressure on the obturator nerve, and a small hard tumor on the inside of the femoral vessels. Attempts at reduction by the taxis have not been very successful. It is better to dissect directly down upon the tumor, expose the bowel, and reduce it by searching for and dividing the stricture.

---

[1] S. D. Gross.

VIII.

THE RESPIRATORY ORGANS.

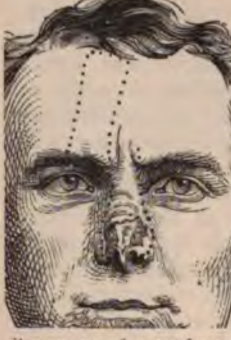
CHAPTER XLVII.

THE NOSE; THE NASAL FOSSÆ; THE ANTRUM.

I. THE NOSE.

Rhinoplasty,[1] the operation for restoring the nose, consists in the transplantation of healthy skin from one part and its adaptation to the formation of the new organ. This process involves making a new scar; the new skin has been taken from the patient's arm, hand, face, and forehead. The last point, being most accessible, is generally preferred, though the pedicle is necessarily long, and must be subjected to considerable strangulation, in consequence of which sloughing very often occurs. The rules which should be observed in performing the operation are as follows:[1] (1) The patch should be taken at such an angle as will diminish as much as possible the twisting of the pedicle; (2) the patch should be placed upon a raw surface; (3) the exposed space from which the patch is removed should be covered in part by the flap raised for the patch.

Fig. 601.



Restoration of apex of nose.

In general, the results of the operation are not satisfactory, owing to the tendency of the new nose to shrivel and collapse; nor have the ingenious methods of supporting the central part, as by a flap from the upper lip, or transplanting a terminal phalanx of the finger,[2] proved of great value. If, however, it is determined to undertake an operation, the various steps to be taken are narrated in the following cases:—

The apex of the nose[1] has been restored thus (Fig. 601): The anterior edges of what remained of both alæ were pared and made straight; an incision was next carried upwards on both sides of the nose, on a line continuous with those edges to the inner extremities of both eyebrows; the included skin was dissected off the nose, and left attached above; an oiled silk pattern of the denuded nose was laid on the forehead, and a larger patch dissected up and turned edgewise on its pedicle, and applied to the exposed surface by sutures along the margins, special care being taken to allow no strain of its attachments; the patch of skin taken from the nose was applied to the lower part of the denuded surface on the forehead. The union of these flaps left prominent tubercles at the fold of their pedicles (Fig. 601); these were removed by curved incisions carried half around at the base of each on its broadest side, unfolding the skin and cutting away the redundant mass (Fig. 601). Union of these relieved the deformity.

---

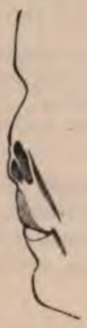
[1] G. Buck.

[2] Hardee.

The columna is restored from the upper lip, as follows: Make two incisions through the entire thickness of the lip so as to leave a tongue about one-third of an inch in width. This flap is turned upward, its extremity adapted to the tip of the nose, which is prepared for it by freshening the edges, and is fastened in its new position by a fine harelip pin and twisted suture.

The ala of the nose may be restored as follows:[1] 1. When a small portion only of the free border of the tip is lost an incision should be made (Fig. 602) across the nose, and the remains of the ala and a portion of the nasal integument thus marked out, dissected down, and attached to the end of the organ. 2. If the loss of substance is greater, a flap of skin of the proper shape to restore the deformity may be raised from the cheek, applied to the previously pared edges of the part requiring it, and fixed there by a few points of fine suture. The material is taken from the forehead as follows:[1] With gutta-percha make a mould of the nose, then, dipping it in hot water, spread it out on the forehead as a guide in forming the flap (Fig. 603); mark out the flap with tincture of iodine, taking care that it is rather square at the angles and not too much rounded off.

Fig. 602.



Deficiency of ala of the nose.

Fig. 603.

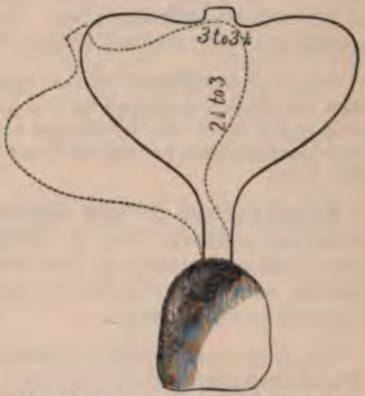


Diagram of flap in rhinoplastic operation.

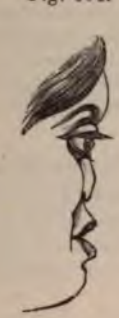
The size will necessarily vary according to the character of the countenance and the extent of loss that has to be repaired. When the whole of the nose requires restoration, it is usually necessary to make it about two and a half to three inches in length by about the same in width at the broadest part; it may be taken from the middle of the forehead or obliquely on one side.

Begin the dissection at the root to avoid the blood, and leave the pedicle long, making the incision on the right side lower than the left, to give an easy twist. The flap being raised, arrest the hemorrhage, and then pare the edges of the nasal surfaces, making a triangular wound with deep marginal grooves shelving inwards; arrest

---

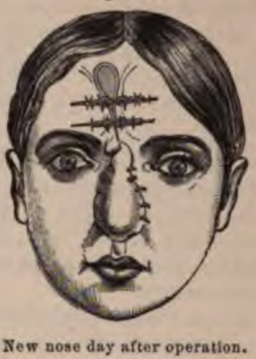
[1] J. E. Erichsen.

Fig. 604.



Depressed nose.

Fig. 605.



New nose day after operation.

hemorrhage by torsion; bring down the flap by a twist from left to right, and attach it by a few points of suture to the edge of the incision around the nasal aperture; insert a pledget of soft lint, smeared with carbolic oil, under the flap; close the wound of the forehead with a suture at its lower part, and cover the remainder with simple dressings. The remaining treatment is that of simple wounds; the pedicle is severed at the end of a month. The columna is made as already described. The new nose must be supported for a considerable time with plugs of lint or gutta-percha tubes. The improvements which an operation makes are very striking (Figs. 604 and 605).

The chief modification of this operation consists in raising the pericranium with the flap,[1] and of making it in part an osteo-plastic operation.[2] The proceeding has few if any advantages over the original operation, and has proved fatal by subsequent necrosis of frontal bone, thrombus in the longitudinal sinus, and death.

Restoration of the entire nose has been effected by two principal methods, viz: 1. Transplantation of flaps from a distant part, Italian method; 2. The formation of a flap from the forehead, Indian method. The latter has been given (Fig. 603); the Italian method[3] is as follows:—

The piece of skin was taken from the left upper arm over the biceps muscle. The surgeon raised the skin by means of broad-bladed forceps, passed a double-edged knife through a horizontal fissure in its blades, and dissected the flap from the muscle, but leaving it attached at both ends; oiled lint was inserted under it to prevent reunion, and renewed daily until suppuration occurred. When the flap began to thicken, and the edges became incrusted, the upper attachment was divided; the flap was then allowed to undergo a process of thickening for about fourteen days when the edges of the flap and of the nasal surfaces were freshened, and the two parts were united by suture, the patient being fixed by an apparatus (Fig. 606). This position was maintained—the sutures removed on the fifth day, the flap dressed—until the twentieth day when the remaining attachment of the flap was severed. This operation is occasionally repeated. Various methods have been devised to transplant skin from distant parts to the region of the nose, but the success has not been marked. Closely allied to this operation is the transplantation of a finger to the nose.[4] The dissection necessary to effect this object was as follows: The second finger of the left hand was selected, and the matrix of the finger nail dissected out. The arm was now fixed in a plastic apparatus so that the finger lay upon the nose. The nasal surface having been prepared an incision was made along the palmar surface of the finger from the second articulation to the

[1] Von Langenbeck.

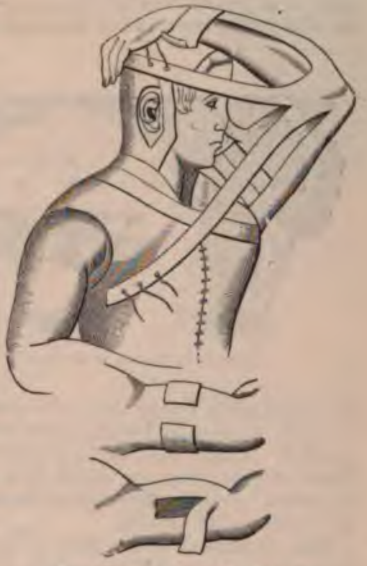
[2] L. Ollier.

[3] Tagliacotius.

[4] T. T. Sabine.

extremity; two lateral flaps were raised throughout this extent, and the finger was placed in position the extremity upward, the palmar surface backward, and the margins of the finger flaps were accurately attached to the margins of the nasal flaps. Union took place; the finger was next amputated near the metacarpo-phalangeal joint; this short phalanx was turned down and formed the columna of the nose; union was complete.

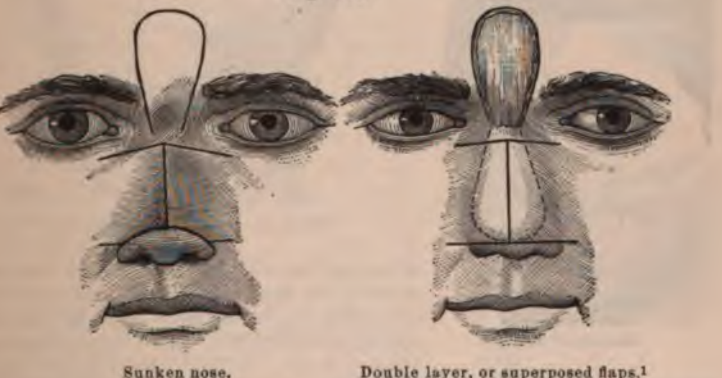
Fig. 606.



Rhinoplasty. Italian method.

A depressed nose may be elevated by the transplantation of patches dissected up with the periosteum adherent. This operation consists in dissecting from the dorsum of the nose two flaps by an incision along its centre, and transverse incisions at either extremity. The next step is to dissect from the forehead a patch which will cover the denuded surface, removing with it the periosteum; this flap is then turned over upon the exposed surface with the integument towards the nasal fossæ, and the periosteum upward (Fig. 607); the two lateral flaps are then laid upon the raw surface of the reflected patch and united in the median line.

Fig. 607.



Sunken nose. Double layer, or superposed flaps.[1]

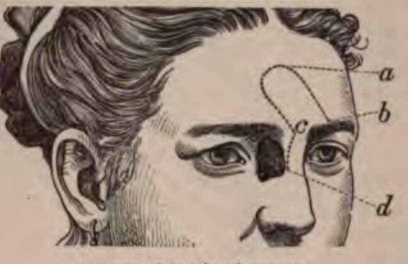
Closure of an opening into the superior meatus of the right nasal fossa[2] (Fig. 608): The skin at the margin of the opening was dissected up and everted with great care, owing to the thinness of the tissues; a pattern of the opening was laid on the forehead and a patch dissected up, *b*, *a*, *c*, having its base in such position as to avoid too much twisting when transferred. A strip of skin, *c*, *d*, intervening between it and the opening was dissected to make room for the patch, but was left attached above the right eyebrow and used to cover the space made by the flap; the patch was fixed by sutures, and warm-water dressings applied. Union took place except at the inner canthus; this was closed at a second operation by raising the edges of the skin and uniting them by sutures.

---

[1] L. Verneuil.

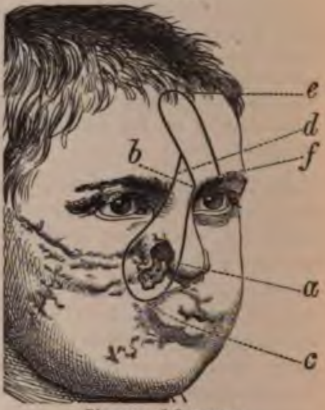
[2] G. Buck.

Fig. 608.



Closure of fistula of meatus.

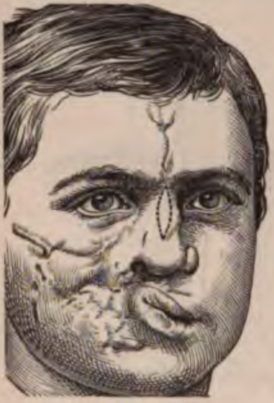
Fig. 609.



Closure of foramen.

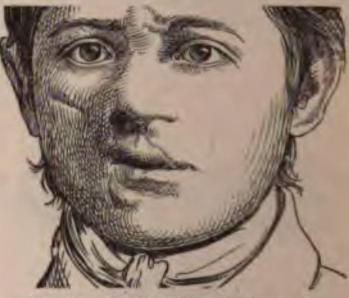
The closure of a foramen (Fig. 609) of the size of the finger has been accomplished by paring the edges of the opening and everting them; next, an incision was made from *a* to *b*, and a corresponding incision on the opposite side; the included skin was dissected up and removed, but should have been reserved to cover the space on the forehead; the pattern of the space to be filled was laid on the forehead, and a flap, *f*, *e*, was dissected up, twisted on its pedicle, and applied to the surface exposed. The result was good (Fig. 610). An elliptical patch was next taken from the elevated mass caused by the pedicle; next, the mouth was made more symmetrical by extending the angle farther towards the cheek by the method already given. The result was favorable (Fig. 611).

Fig. 610.



Shaping mouth.

Fig. 611.



Foramen closed and mouth shaped.

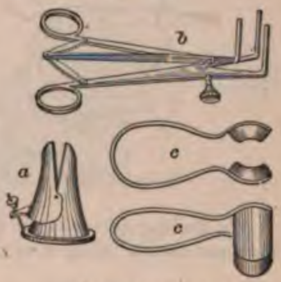
II. THE NASAL FOSSÆ.

The nasal fossæ open widely to the air in front through the nostrils, and behind into the pharynx.

The floor is horizontal, but the roof slopes forwards and backwards from the cribriform plate, making the vertical depth greatest in the middle; the outer walls are made irregular by the passages which the turbinated bones create, and numerous openings leading to the air-cells; the meatuses, or passages, are three in number; namely, superior, middle, and inferior; the septum is formed chiefly by the perpendicular plate of the ethmoid and vomer.[1]

Exploration of the fossæ may be made by inspection and palpation. Inspection, or rhinoscopy, may be anterior or posterior. Cocaine facilitates explorations and operations upon the interior of the nose, by reducing sensibility and causing reduction of the mucous membrane. First cleanse the nostril with a spray or current of lukewarm alkaline solution, and then apply a four per cent. solution of cocaine to the mucous membrane; when its effect is complete cause the patient to blow forcibly through the affected nostril; if this fail, resort to instruments. For anterior inspection, select a speculum *a*,[2] *b*,[3] *c*[4] (Fig. 612) adapted to the case; place the patient in a good light, or use artificial light, introduce the speculum and dilate its branches.

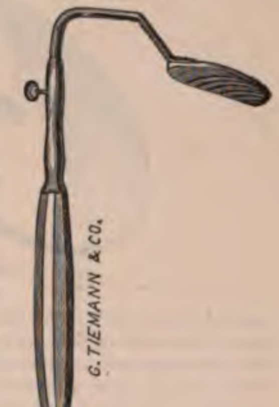
Fig. 612.



Nasal instruments.

The parts which can be seen are the interior of the nostrils, the anterior portion of the turbinated bone, a portion of the middle concha, and a portion of the floor and septum of the nasal cavity; if the meatus is large the posterior wall of the pharynx and even the orifices of the Eustachian tubes may be observed.[4]

Fig. 613.



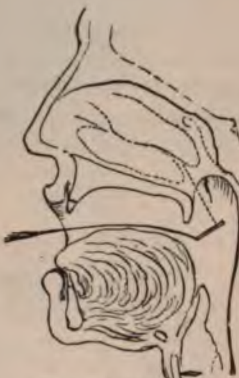
Türk's tongue depressor.

For posterior inspection (Fig. 614), select a suitable spatula (Fig. 613) and mirror (Fig. 453), or better the rhinoscope. The patient seated in front of a good light, the mouth opened widely, the tongue behind the lower incisors, where it may be depressed by the spatula, pass the mirror into the pharynx, over the median line of the tongue, until it is in the free space between the base of the tongue, the laryngeal opening, the posterior wall of the pharynx, and the velum; it should stand on the right or left side, to avoid the uvula, with its upper edge brought close to the posterior wall of the pharynx; the problem is to introduce the mirror and not touch the patient[1] (Fig. 614).

---

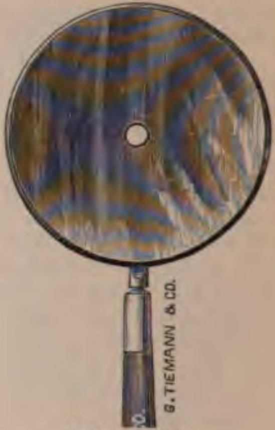
[1] L. Holden.
[2] Davis and Collins.
[3] D. B. Delavan.
[4] L. Elsberg.

Fig. 614.



Posterior rhinoscopy.[2]

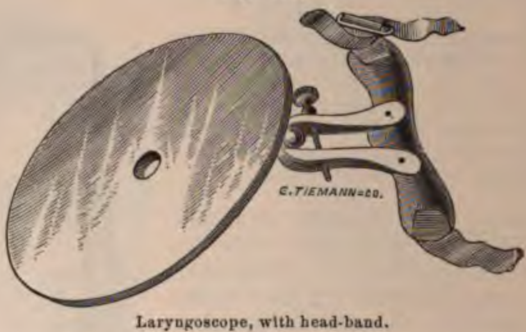
Fig. 615.



Reflecting mirror.

A reflecting mirror adds much to the illumination of the parts (Fig. 615); the hand mirror being introduced, the light is reflected from the external mirror upon the internal.[3] The forehead reflector is a round, slightly concave mirror, three and a half or four inches in diameter, with a perforation in its centre, or with the glass left unsilvered at that point; its focal distance should be about fifteen inches, and attached to an elastic head-band. The soft palate often seriously obstructs the inspection by falling backwards against the pharyngeal wall; this can only be overcome in many patients by a hook,[4] or the elevator of the mirror. The parts to be seen are the vault of the pharynx, the septum in the median line, the posterior portion of the middle turbinated bone, and part of the middle meatus; part only of the superior and inferior turbinated bones are seen. The posterior surface of the velum is exposed, and late-

Fig. 616.



Laryngoscope, with head-band.

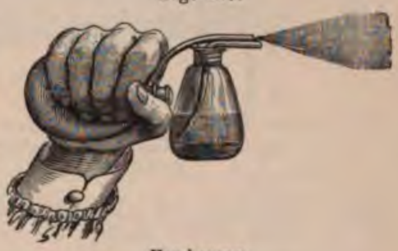
---

[1] B. Fraenkel. [2] T. R. Brown. [3] A. E. Durham. [4] L. Elsberg.

rally the orifices of the Eustachian tubes.[1] Palpation is absolutely necessary to render conclusions certain. The patient sitting, pass the forefinger, during inspiration, behind the velum, and turn the point upwards as far as the posterior nares; the points examined are, the posterior surface of the velum, the septum, and the pharyngeal orifices of the Eustachian tubes. To avoid retching, the examination must not be prolonged; points that cannot be reached by the finger may be palpated with the laryngeal sound.[2]

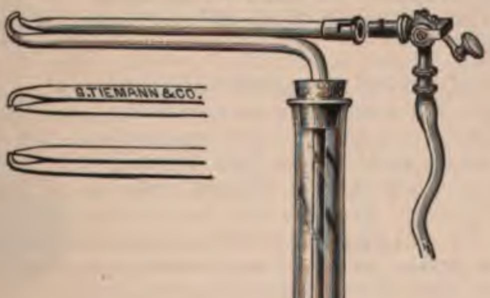
Medication of the fossæ and parts posterior may be effected by the spray and the douche. It is alleged that inflammation of the ear may be caused by the penetration of liquids to the cavity of the middle ear through the Eustachian tubes. To prevent the occurrence of this accident direct the patient to abstain from efforts at swallowing by drawing out the tongue, and to breathe calmly with widely opened mouth.[1] The spray (Fig. 617), medicated, may be thrown into all divisions of the fossæ through the anterior meatus; its application to the posterior nares and parts adjacent is effected by an atomizer having an upward cast, introduced behind the soft palate (Fig. 618). When the douche is used, the liquid enters one nostril; the velum is elevated and closely approximated to the posterior pharyngeal wall so that the nasal cavity is closed posteriorly in such manner that the fluid running through the posterior nares escapes by the opposite nostril and is received into a vessel. The entire nose and upper part of the pharynx are thus thoroughly bathed.[2]

Fig. 617.



Hand spray.

Fig. 618.



Sass spray tubes.

The little vial of this hand apparatus (Fig. 617) is connected with the tube by means of a metal cup having a coarse screw thread within it corresponding to a similar thread cast upon the neck of the vial, so that the atomizer may be held and operated with one hand without danger that the vial will be detached. Whe the vial is turned into the cap so as nearly to exclude air, the spray is rendere exceedingly fine; the tubes are of such length as to permit the atomized flui to be applied directly to the laryngeal and pharyngeal regions.

---

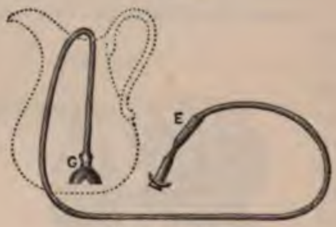
[1] L. Elsberg.

[2] B. Fraenkel.

The most efficient spray apparatus is that connected with a chamber of compressed air. The chamber is filled by a hand force-pump, and a tube connects it with the spray tubes (Fig. 618); these tubes[1] are made of glass drawn to a fine point, and have an upward, downward, and forward cast of the jet of spray. An attachment enables the operator, by pressing his thumb on a button, to open a valve and allow the air to escape through the spray tube.

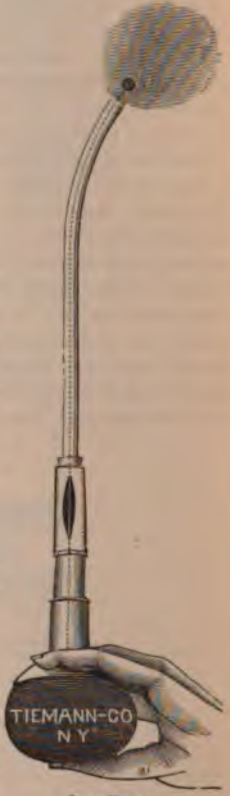
A convenient douche (Fig. 619) may be made with the water-pitcher. To start the current, put the weight and about half the rubber tube with it into the liquid. The reservoir is placed higher than the head, and the rubber tube is grasped near the nozzle, between the thumb and finger, so as to control the current. The nozzle is then depressed enough to allow a little of the liquid to escape, thereby expelling air from the tube; it is then pressed gently into the nostril, and the grasp slightly relaxed, when the current will enter and fill the whole cavity of the nose, and escape by the opposite nostril; the head at this time being thrown slightly forward over a basin, and the mouth kept open. The fountain douche is a still more convenient apparatus.[2]

Fig. 619.



Nasal douche.

Fig. 620.



Insufflator.

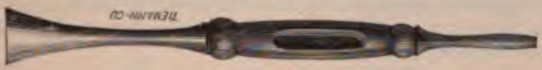
Insufflation of powders may be made anteriorly or posteriorly; the former requires a tube having a chamber for the powder; the powder may be blown out, or an India-rubber ball, by which the powder is driven out and diffused, may be attached (Fig. 620). But any tube, or even a quill with a bit of India-rubber tube attached, may be used for the purpose;[3] the latter may be effected by glass, hard rubber (Fig. 621), or metal tubes, curved at the extremity, introduced behind the soft palate. Fluids may be applied with a brush or sponge. The brush and sponge-holder should be of sufficient length and appropriate curvature for making the applications either into the nostrils or through the mouth.[2]

---

[1] L. F. Sass. [2] L. Elsberg. [3] H. Knapp.

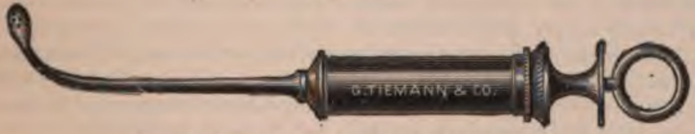
A syringe, with a suitably curved nozzle, adapted to injections into the posterior nares, has the advantage of the application of fluids directly to the diseased parts, without the danger of their entrance into the middle ear through the Eustachian tube. If the nozzle has several perforations, the fluids may be distributed over a large area as a coarse spray (Fig. 622).

Fig. 621.



Rubber tube.[1]

Fig. 622.



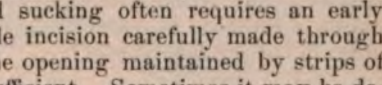
Hard rubber laryngeal and posterior nares syringe.

Imperforate nose may be congenital; it is then caused by a membrane stretched across the nostrils, or by firm fibrous tissue, or by simple continuity of the integument. In congenital closure the interference with respiration and sucking often requires an early operation. In most cases a simple incision carefully made through the obstructing membrane, and the opening maintained by strips of lint, or a short elastic canula, is sufficient. Sometimes it may be desirable to excise a portion of the obstructing tissue. When there is no indication of the opening of the nostril, the adherent parts must be gradually and cautiously divided until the nasal canal is restored.

Occlusion occurs at different points. Closure of the nostrils may be by membrane or by fibrous tissue, or result from catarrhal inflammation;[1] or one ala, or both, may be adherent to the septum, or even to the upper lip. As these defects interfere with respiration and prevent the infant from sucking freely, they demand early operation. Make a simple incision of sufficient extent carefully through the membrane, or excise a portion and keep it open by lint or canula until the cut surfaces are healed. Bending of the cartilaginous or bony septum causes more or less complete closure on the convex side. If the cartilaginous septum alone is affected, excise a portion on the convex side by slicing with a narrow probe-pointed bistoury, care being taken to avoid perforating it.[2] First use cocaine.

The bony septum may be fractured and made straight, as follows:[3] Introduce a pair of smooth, thin-bladed forceps, grasp the septum and close the blades; the septum is fractured and the fragments are brought into a straight position; a metal clamp with thin blades is now introduced and tightened; this apparatus is retained as a

Fig. 623.



Nasal splints.

---

[1] L. Elsberg. [2] S. D. Gross. [3] W. Adams.

splint until the bones unite, which usually occurs in two weeks; the clamp must not be too tight (Fig. 623).

Narrowing, or stenosis, of the deeper passages may be sufficiently overcome in infants by the use of hollow bougies as dilators, or, in more severe cases, by forcible distension by means of a pair of thin, long-armed forceps, by the opening of which the abnormally approximated bones are separated.[1] Bony closure of the posterior nares may exist from a continuation of the free posterior border of the palate bones upward and backward. This occlusion may be overcome by perforation of the bony plate.[2]

Hemorrhage, epistaxis, is of very common occurrence, owing to the immense distribution of bloodvessels throughout the cavities, and the existence of cavernous bodies between the periosteum and mucous membrane of the turbinated bones. Bleeding may be spontaneous, or result from injury, and when severe there is a rupture of vessels. The diagnosis is easy when the hemorrhage continues, but if it has ceased, an examination of the nasal passages, and the history of the attack, determine its origin.[2] In the treatment, discrimination and judgment are as frequently required as skill, for it is as important to decide wisely as to the necessity of arrest, as to devise and apply the best means of effecting it. In many cases, the conditions which have given rise to the bleeding require treatment, rather than the incidental and temporary flow of blood; the non-recurrence of periodical or habitual epistaxis may betoken the approach of danger. In others, the sudden arrest of bleeding by surgical interference may be followed by symptoms of the gravest import.[3]

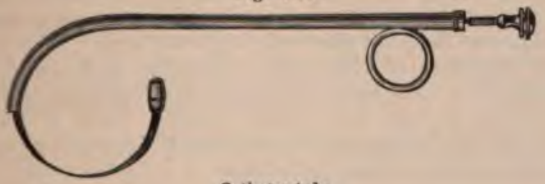
In general, the hemorrhage should be arrested when it seems to be dangerous, or when, by its severity or the frequency of its recurrence, it begins to produce symptoms of acute or chronic anæmia. The end sought in treatment is the formation of a coagulum. The simple measures should be first employed. Place the patient in the sitting posture, the head inclined slightly forward; remove all articles from the neck which prevent the free flow of blood; secure the most perfect possible state of rest of mind and body, and encourage quiet respiration without speaking, or blowing the nose.[2] The simple means are cold to the nose and forehead, or to the back of the neck, elevation of the arms above the head, astringent injections as of alum, tannin, zinci sulph., astringent spray, mustard foot-baths. As, in a large number of cases, the bleeding spot is near the anterior and lower border of the septum,[3] the bleeding may often be arrested by pressing the ala of the affected side against the septum in such a manner as to close the nostril, and the front and upper part of the nose; or the finger may be applied directly in the nostril; or a compress of lint, tied with a string with which to remove it, may be introduced into the nostril;[2] wicks or strips of linen may be introduced through the nose to the pharynx,[4] and they may be sprinkled with tannin,[5] or dipped in persulphate of iron,[6] to increase their styptic qualities. Antipyrine in aqueous solution, 1 to 30, is a safe and powerful hæmostatic; apply it on lint, inserted as far as possible, and then compress the nose so as to bring the solution in contact with a large surface of mucous membrane.[7] Cocaine applied in a 4 per cent. solution relieves congestion.

If these measures fail, either compression must be made by the rhineurynter, or the posterior nares must be plugged. The former is a simple inflative balloon which is introduced into the nostril while empty, and then inflated by means of a flexible tube, and maintained full by closure of a stopcock. The posterior nares are plugged by means of the catheter tube (Fig. 624).[1] Introduce the tube, with spring withdrawn, along the floor of the nose (Fig. 625), until the pharynx is reached; advance the spring, which, after passing around the velum, appears in the mouth; attach a thread to the tampon through the small eye in the button at the end of the spring, and withdraw it; the tampon (Fig. 625) passes backward behind the soft palate; as the tube is withdrawn the plug is lodged in the posterior nares; the threads of the tampon must be brought out, one from the mouth and the other from the nose, and knotted. When the tampon is removed, untie the threads and draw it backwards through the mouth.

---

[1] Hoppé; B. Fraenkel.
[2] B. Fraenkel.
[3] A. E. Durham.
[4] Thompson.
[5] Curtin.
[6] L. Elsberg.
[7] Lavrand.

Fig. 624.



Catheter tube.

Fig. 625.

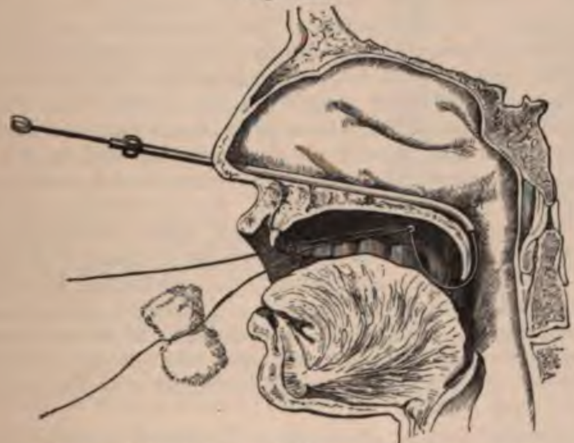


Diagram of plugging the nostril by means of Bellocq's sound.

Foreign bodies may be introduced, or may form in the nasal cavities. The former embrace all substances which may be forced through the anterior or posterior meatus; and the latter are confined to concretions, calculi, which form around some nucleus. The symptoms vary; the substances may remain long in the nasal cavities without causing any trouble; but, in general, their immediate effect is circumscribed inflammation, with purulent, bloody, and often fetid secretions. The diagnosis is made out from the history and exploration. If the history is doubtful, inspect the cavities, remembering that the foreign body may be covered with secretions; finally, explore with the probe, distinguishing, by the sensation, sound, and mobility, between the movable body and the bone.[1] Early removal must follow detection of the body. Sneezing and the douche are sometimes effective. The most convenient instruments are thin, short, straight dressing-forceps, and small scoops. Care is requisite in seizing the body lest it be pushed more deeply into the cavity.[2] First apply a four per cent. solution of cocaine.

---

[1] Bellocq.

Abscess forms in the epidermoid lining of the nose, the result of inflammation, either spontaneous or traumatic. The course of this affection is usually rapid, and the abscess opens at the end of a few days, with relief; it may assume a phlegmonous character, attended with great swelling of the mucous membrane, œdematous swelling of the external parts of the nose and adjacent parts of the face and lower eyelids, severe pain and fever, and terminate in widespread suppuration; or the inflammation may even reach the meninges of the brain.[1] The treatment of the mild form should be cold, leeching, and early opening of the abscess. The phlegmonous variety requires active measures to promote local suppuration, as applications of warm vapor, cloths wrung out of hot water, poultices, free incisions where the skin is tense, and early opening of the abscess.[3] Acute abscess may form in the septum and give rise to severe pain and high fever; the inflammation may extend to the upper lip and to the frontal sinuses and lachrymal passages; the surface is red, shining, tender on pressure, and has an extensive base. In the treatment prevent the formation of pus if possible; but failing, open the abscess by free incision as soon as it is formed, followed by soothing and astringent washes.[2] Chronic abscess commences often without assignable cause, and progresses insidiously; it may be mistaken for polypus or thickening of the mucous membrane; in a majority of cases it terminates in perforation of the septum; the abscess must be opened early, and perforation prevented by injections of detergent solutions, as arg. nit., zinci sulph., acid. carbol.

Papillomata[4] consist of immature connective tissue having a papillary arrangement with imprisoned portions of muciparous glands; they are generally situated on the inner surface of the alæ, are met with more frequently in children, cause irritation, but do not attain sufficient size to cause much embarrassment of respiration or alteration of the voice; they should be removed with curved scissors, or twisted off with forceps after the surface is treated with cocaine.

Mucous polypi[4] are localized hypertrophies, or outgrowths of the mucous membrane and submucous tissue; in consistence they are soft, pulpy, and somewhat elastic; in color pale, yellowish, grayish, or slightly greenish; in appearance shining and semi-transparent; they are, as a rule, pedunculated and pendulous, and more or less movable, single or multiple, pear-shaped, or irregularly lobulated to fit the cavities in which they lie.

---

[1] B. Fraenkel.

[2] A. E. Durham.

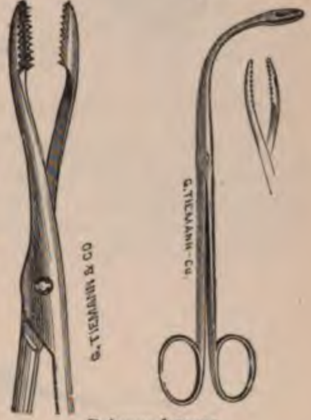
[3] W. Parker.

[4] M. Mackenzie.

They rarely, if ever, spring from the mucous membrane covering the septum; are most frequently connected with that which covers the superior and middle turbinated bones, and lines the superior and middle meatus, but may arise in the lower meatus, or be attached to the inferior turbinated bone, or the roof of the nose, the ethmoidal cells, or even the frontal sinuses. In the nostril they tend to fill the cavity and protrude forwards or backwards, sometimes expanding the alæ and even the nasal processes of the superior maxilla, or hanging down behind the uvula into the pharynx.

The symptoms are fulness and weight about the affected nostril, which gradually becomes so much obstructed as to interfere with respiration and the voice, especially during damp weather, when the growths become fuller and paler in color; the diagnosis is generally easily made with the nasal speculum and rhinoscope. The treatment is removal. Evulsion is the most simple, certain, and rapid method of removal, and may be performed with forceps or the snare.[1] The forceps should be strong, short, with blades slightly bent laterally, grooved longitudinally, and well serrated along their edges (Fig. 626); if the polypus is situated posteriorly, and must be removed through the mouth, the forceps must have the proper curve (Fig. 627).[2]

Fig. 626. Fig. 627.



Polypus forceps.

Anæsthetics may be required, especially in delicate women, but there are marked advantages when the patient is able to submit without this agent, such as clearing the nasal passages, and preventing the entrance of blood into the air-passages.[1] For the purposes of local anæsthesia cocaine answers an excellent purpose. Great care must be exercised in applying the forceps and removing the growths to avoid the risk of inflicting serious damage by tearing away unnecessarily the mucous membrane or the turbinated bone.[2]

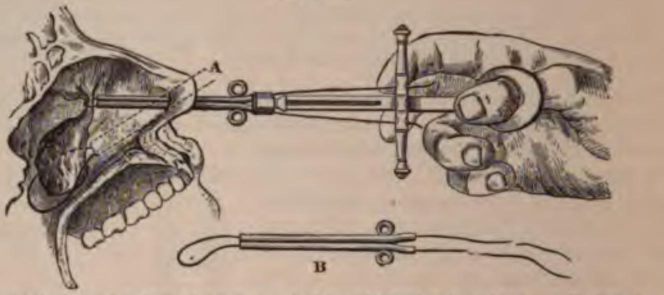
Place the patient in a chair, in front of a good light, with the head thrown back and supported by an assistant, who also elevates the tip of the nose, as the external opening of the nostril is on a lower level than the floor of the nasal cavity; introduce the blades of the forceps closed into the nose; glide them along the floor or septum until their extremities have reached and passed to some extent the visible portion of the polypus; open the blades in a vertical or oblique direction, turned upwards and outwards so as to include as much as possible of the growth; seize it firmly, and tear it from its attachments by traction and rotation of the forceps on their long axis. If the polypus yields without being detached, grasp it close to its roots with a second forceps, and twist it off at its origin.[2] When the growth is situated far back, pass the forefinger of the left hand round the soft palate into the posterior nares, and guide the forceps, introduced from the front, to the peduncle; if the polypus is very large, and attached at several points, extract it in successive portions.[1] If the polypus is situated posteriorly and hangs down into the pharynx, it may be seized by properly-curved forceps passed through the mouth, and behind the soft palate,[2] or it may be detached by the wire écraseur introduced through the nostril and pushed backward into the pharynx (Fig. 628). The thermo-cautery may be used, when the growth is easily accessible, for the destruction of the base.

---

[1] M. Mackenzie.

[2] A. E. Durham.

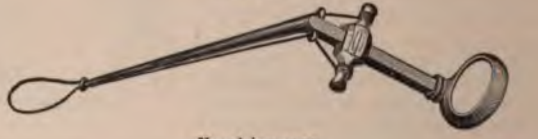
Fig. 628.



Removal of nasal polypus by noose. *A.* Line of introduction of snare. *B.* Snare.

The snare best adapted for evulsion (Fig. 629)[3] consists of the nasal portion, the ring, the cross-piece, and a quadrangular stem; there is a hinge which gives any angle to the shaft; in preparing it, pass a wire through the doubly-perforated extremity, and through two small holes, and attach it on either side with the sliding cross-piece, making a loop beyond the bulbous end; in using it, advance the cross-piece as far as possible, which projects the loop; introduce this loop into the nostrils with the end of the shaft, and pass it over the polypus to its pedicle; draw the cross-piece down the shaft, fixing the loop firmly to the growth, then twist and pull until the growth is detached.[2] Polypi have been removed by the forefingers, one pressing through the nostril anteriorly, and the other posteriorly, until they are detached.[4] The galvano-écraseur may be used;[5] the operation is attended with little pain, and there is no risk of hemorrhage; but as the wire can rarely be adjusted to the pedicle, and no traction is made, the growth has to be removed in slices.[1] After the removal,

Fig. 629.



Nasal écraseur.

---

[1] M. Mackenzie. [2] A. E. Durham. [3] J. H. Hilton.
[4] S. D. Gross. [5] Thudichum.

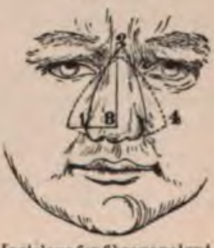
the hemorrhage usually ceases spontaneously, but may require the application of ice, or even the plugging of the nostrils; injections of astringents, or insufflation of tannic acid or other powders are useful in removing remaining portions of the growth.[1]

Rhinoliths, nasal stones, consist of a deposit of phosphate of lime and mucus, usually upon hardened secretions or upon a foreign body. They are liable to be mistaken for growths. They should be removed with forceps, or a wire snare, after obtaining the effect of cocaine; it may be possible to crush them.

Rhinoliths have been expelled spontaneously, when the concretions were very small; hot water injected through the opposite nostril may in some cases prove effective in dislodging them; sternutatories may be tried; the dental drill might be serviceable. In some instances it is better to push the stone back into the pharynx; in this case strict precaution must be adopted to prevent it from falling into the larynx.

The fibrous polypus[2] springs from the periosteum, and is composed of bundles of compact connective tissue interspersed by elongated nuclei; some are of almost cartilaginous hardness, and the softer varieties are very vascular. It may grow from any part of the walls of the nasal fossa, but more frequently it is attached to the basilar process at the base of the skull, and first appears in the pharynx as a naso-pharyngeal polypus; it is usually distinctly pedunculated, but forms adhesions to opposing surfaces; in appearance, it is a red, fleshy-looking mass, hard, and resisting to the probe, tender, liable to bleed, frequently ulcerated, with a purulent and even fetid discharge; the growth at first causes the ordinary symptoms of mucous polypus, as nasal obstruction, epistaxis, mucous discharge; but as it spreads it causes absorption and displacement of the surrounding structures, pushes the septum to one side, penetrates the orbit, extrudes the eyeballs, forces the walls of the antrum outwards, causing the frog-face deformity, and even enters the cranium and compresses the brain; the treatment is thorough removal at the earliest stage practicable, and the result is generally favorable. Extirpation may sometimes be effected by the forceps, ligature, or galvano-caustic, at an early stage, when the growth has a small pedicle within easy reach. If the tumor is larger, it may suffice to cut through the alæ of the nose along their junction with the cheek, 1, 2 (Fig. 630), the nasal processes of the maxillæ and the skin with the mucous membrane covering them, and the septum; turn the nose upwards, remove the growths, and replace the parts;[1] or the nose may be divided above by a Ω incision, 1, 2, 1 (Fig. 630), and turned downwards.[2] If still larger, excise the nasal bone thus:[3] Make an incision from the junction of the frontal and nasal bones, 2, 3 (Fig. 630), vertically downwards along the mesial line of the nose to the upper margin of the alar cartilage, thence outwards to the cheek, 1 (Fig. 630), dissect off this triangular flap, avoiding the periosteum, and

Fig. 630.



Incisions for fibrous polypi.

---

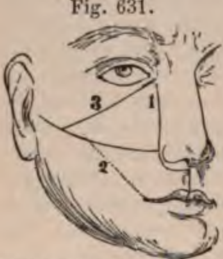
[1] A. E. Durham. [2] L. Ollier. [3] Von Langenbeck.

sever the alar cartilage from its attachments to the bone superiorly; separate the nasal bone from its fellow on the opposite side by bone nippers, and in the same manner cut away the nasal process of the superior maxillary from the body; with an elevator, raise the quadrilateral plate of bone upward so as to lay open the whole upper part of the nasal cavity; remove the tumor through the gap thus made, either by the knife or forceps; replace the parts disturbed accurately.

The larger tumors may also be removed through an incision of the hard palate[1] thus: Divide the soft palate throughout its whole extent and thickness in the middle line; next make a longitudinal incision along the posterior half of the hard palate down to the bone, and two others obliquely outwards, one on each side, to the alveolar process; raise these flaps from the bone and reflect them outwards; perforate the palate and cut it away with forceps; divide the periosteum and mucous membrane of the floor of the nose and turn the flaps aside; excise as much of the vomer as may be necessary to expose the tumor, which may now be readily removed, unless of large size and too extensively attached; the opening in the palate should not be closed for some time after the operation, when staphylorraphy may be performed.

The largest growths require excision of the upper jaw;[2] extract the first incisor of the side affected; make an incision from the inner canthus, along the side of the nose and through the lip, in the median line, 1 (Fig. 631); a second incision, 2 (Fig. 631), may be required from the malar bone to the angle of the mouth or ala; or 3 (Fig. 631), to the inner canthus; dissect up the flap thus formed and expose the bone; with forceps separate the bone in the median line from its fellow; divide the portion between the nostril and the inner margin of the orbit; saw through the malar tuberosity, and divide the soft palate in the median line; carefully free the bone from the superior maxillary nerve and other soft parts; separate the orbital plate, when it can be saved, with cutting forceps, and with lion forceps seize the mass and twist it out; remove the growth, apply the actual cautery to its attachments to arrest hemorrhage and destroy the remnants of the tumor; carefully readjust the parts and retain them with sutures.

Fig. 631.



Excision for fibrous polypi.

Cartilaginous tumors spring from the cartilaginous septum and the frontal and ethmoidal cells; as a rule they are hard, but may be quite soft; are never pedunculated and seldom ulcerate; when attached to the septum or fossæ, and accessible, they must be removed, as described.[3]

Osseous tumors may be exostoses, or ossified, cartilaginous, sarcomatous growths, or independent bony tumors; they are recognized by their hardness; exostoses must be cut off, but the osseous tumor must be fully exposed by methods given, and extirpated.[4] The burr of the dental engine is a very effective instrument for removing the base of the tumor.[5]

---

[1] E. Nélaton.
[2] Flaubert; Tatum.
[3] M. Mackenzie.
[4] A. E. Durham.
[5] J. S. Cohen.

Sarcomata are the representatives of the quasi-malignant growths; they are attached to the sides of the nasal cavities, are hard or soft; they may result from the degeneration of polypi, or spring up as sarcoma; they appear as fleshy, lobulated, succulent tumors, bright red, or of a dirty ashen hue, readily softening, ulcerating, bleeding, and attended by fetid discharges and severe pain; they must be removed, and generally by exsection of the upper jaw.[1]

Cancer originating in the nasal fossæ is rare, and attempts at removal have rarely given satisfaction.[2]

III. THE ANTRUM.

The antrum, maxillary sinus, is a large cavity in the body of the superior maxilla, lying above the molar teeth and below the orbital plate, lined in the fresh state by mucous membrane, and communicating with the middle meatus of the nose.[3]

The relations of the antrum to the teeth vary extremely; it may extend so as to be in immediate relation to all of the teeth of the true maxilla, or may be so contracted as to correspond with only two or three of the central ones; occasionally a root or roots of the first molar extend into the cavity, free of any bony covering, and merely overlaid by the mucous membrane lining the sinus; the orifice which opens into the middle meatus varies from the size of a probe to that of the end of a little finger, 2 (Fig. 447).[4]

Dropsy may be due to the extension of nasal catarrh to the mucous membrane of the antrum,[5] or to the formation of cysts.[6] It appears as a gradual and generally painless expansion of the bone, and may encroach upon the nose, the orbit, or cavity of the mouth, causing obstruction and deformity.[7] For correct diagnosis perforations may be necessary. The treatment is evacuation of the contents by puncture at the most dependent part, or where bulging appears;[8] in some cases the front wall of the antrum must be cut away by raising the cheek at that point without dividing the lip,[9] the cavity cleansed and iodine applied to its walls, 3 (Fig. 631).

Abscess[4] results, in the majority of cases, from dental caries or alveolar abscess; there is a dull aching pain in the cheek, with heat, redness, and fulness of the soft parts externally; there may at first be purulent discharge from the nose, but the swelling of the mucous membrane soon closes the sinus; there is now throbbing pain, rigors, fever, expansion of the jaw, elevation of the malar bones, projection of the molar teeth, depression of the arch of the palate bone; the finger seldom fails to detect the fluctuation, but exploration may be made with a fine trocar and canula; the pus may escape into the nose, through the cheek, into an alveolar cavity, through the floor of the orbit; before the abscess has formed, and when as yet it is only imminent, remove any carious tooth or teeth in the neighborhood and apply leeches and fomentations; when pus has formed, extract all carious teeth from the maxilla involved, and if the pus is discharged from the cavity of either, enlarge the opening sufficiently to give free exit to the pus in the antrum. If there is no carious tooth, proceed as follows: Perforate the antrum by extracting the first permanent molar tooth, and passing a trocar into the cavity through its socket; the forefinger should be extended on the shaft of the trocar as a guard, and the instruments pressed forward with an even, rotating motion; avoid the sudden giving way of the wall of the antrum and the plunge of the trocar through the wall of the orbit; if the teeth of the affected side have been long removed, the antrum is more readily perforated at the base of the malar process of the maxillary bone, over the region formerly occupied by the second or third molar tooth, by dividing the mucous membrane and employing a large trocar or a strong pair of scissors;[1] when the antrum is opened, wash it out thoroughly with warm water, followed by carbolic acid solutions; the entrance of food must be prevented by plugs of hard rubber, or by a plate fitted to the opening, with an opening which may be closed by a cork. It is sometimes practicable to open the passage from the cavity of the antrum to the nasal fossæ[2] with a probe properly directed, 3 (Fig. 625).

---

[1] M. Mackenzie.
[2] F. James.
[3] Quain's Anat.
[4] S. J. A. Salter.
[5] B. Fraenkel.
[6] M. Giraldès.
[7] T. Bryant.
[8] S. D. Gross.
[9] Sir W. Fergusson.

If these teeth are sound, or by treatment can be preserved as useful teeth, they ought in no case to be destroyed. In such a case perforate the anterior wall, by the small trephine, or by the surgical engine; no special trephine is necessary.[3]

CHAPTER LXVIII.

THE LARYNX.

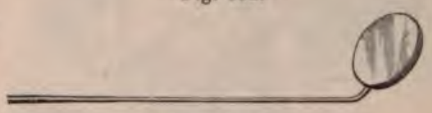
THE organ of the voice is situated at the top of the trachea, below the root of the tongue and the hyoid bone; it consists of a framework of cartilages connected by ligaments, and provided with appropriate muscles, bloodvessels, and nerves, and lined with mucous membrane; the cavity gradually narrows from its aperture downward to the space between the inferior edges of the orifices of the laryngeal ventricles; the narrowest portion of this space is the glottis, below which the cavity gradually widens and assumes the circular form.[4]

Its interior is divided into two cavities, an upper and a lower, which are separated by two horizontal lateral projections constituting the glottis, and which communicate by a cleft-like space between these projections, the rima glottidis.[5]

Before using the laryngeal mirror, to prevent deposits of moisture, warm it over a flame, as the immersion in hot water, recommended by some, favors the decomposition of the silver coating of the glass.

[1] B. C. Brodie.
[2] S. J. A. Salter.
[3] W. H. Keene.
[4] J. Leidy.
[5] L. Elsberg.

Fig. 632.



Laryngeal mirror.

Examination of the larynx is made with the mirror (Fig. 632). It may be made in the open air, before a window, or in front of a lamp or other artificial light, thus: If the patient's throat is sensitive first apply a four per cent. solution of cocaine to the palate and pharynx; in fifteen minutes the mirror can be freely used. Sit in front of the patient at such a distance as to obtain distinct and clear visions of the soft palate and wall of the pharynx; to explore the pharynx, direct the head to be slightly bent forwards (Fig. 633), so that the lower border of the upper incisor teeth shall be on a plane horizontal with the base of the soft palate, the mouth widely distended, the tongue thrust forwards towards the chin, and held by the patient with a napkin; take the stem of the mirror as in handling a pen, and, during a deep inspiration, pass the mirror, warmed, well above the tongue, directly backwards, until it reaches the uvula; now flex the wrist and place the mirror with the lower border in front of the posterior wall of the pharynx; the uvula and soft palate are pushed backwards and somewhat upwards; the stem of the mirror is horizontal, and the reflecting surface looking obliquely downwards and backwards.[1] To explore the interior of the larynx, simply incline the head backwards (Fig. 634).

Fig. 633.

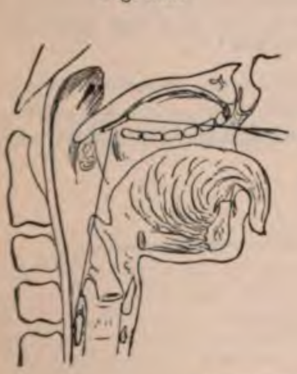
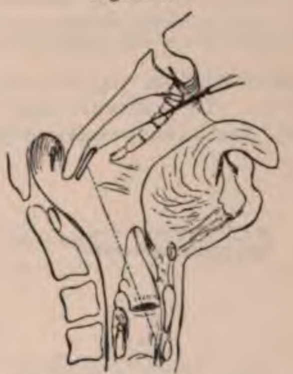


Fig. 634.



Examination of larynx with mirror.

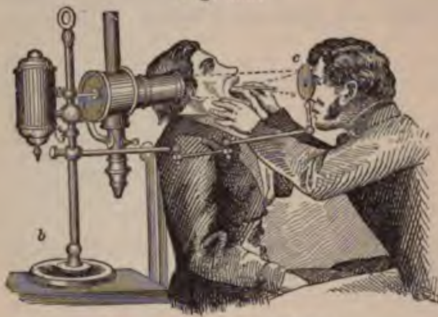
If artificial light is used with a reflector (Fig. 635), the lamp, the mouth of the patient, and the eyes of the observer, should be as nearly as possible in the same plane; the reflector should be arranged so as to throw the light into the open mouth of the patient and illuminate the middle of the soft palate, the uvula, and posterior pharyngeal wall; and then the mirror may be introduced.[2] The pharynx and larynx are brought into suitable position for examination

---

[1] J. S. Cohen.

[2] A. E. Durham.

Fig. 635.



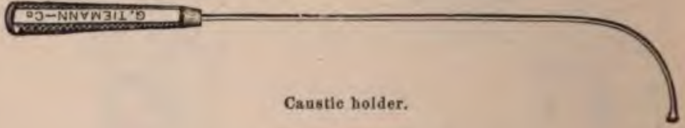
Examination with reflector.

when the patient prononnces *ai*, as in *fair*, for the larynx rises, the velum and uvula are lifted, and the tongue is depressed. In this instrument the light is reflected from the mirror, *c*, to the small mirror held at the posterior part of the mouth, the uvula resting upon its back.

The individual parts revealed by the laryngoscope, which are otherwise completely invisible or rarely or never seen without difficulty, are: The postero-inferior portion of the base of the tongue; the posterior wall of the pharynx down to its attachment to the cricoid and arytenoid cartilages; the upper cavity of the larynx with all its anatomical relations and contents; a portion of the lower cavity of the larynx, particularly its anterior wall; the anterior wall, and sometimes lateral walls of the trachea for a considerable distance, and under favorable circumstances, down to the bifurcation, and in a few instances even throughout the whole length of the right bronchus.[1]

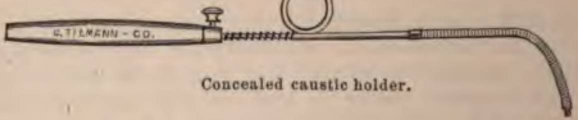
Medication may be with solid substances, powders, liquids, or vapors. The solids are most readily applied by means of a moderately thick aluminium or silver wire, mounted in a slender handle, and hollowed into a tiny cup (Fig. 636), or roughened at the extremity, which may be dipped into various substances, as nitrate of silver, or

Fig. 636.



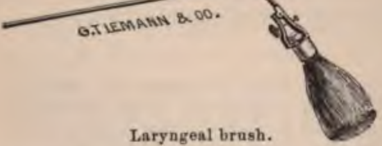
Caustic holder.

Fig. 637.



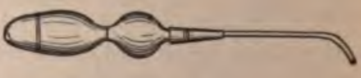
Concealed caustic holder.

Fig. 638.



Laryngeal brush.

Fig. 639.



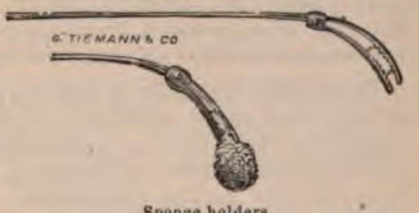
Insufflator.

---

[1] L. Elsberg.

chloride of zinc while in a state of fusion; the wire may be easily bent at any requisite angle, and there is no danger of any considerable portion breaking off. An ingenious concealed caustic holder (Fig. 637) may be used, which, by retraction of the tube, uncovers the caustic at the point of application. Powders may be applied with a brush (Fig. 638) or by means of the insufflator[1] (Fig. 639). Liquids may be applied by means of a sponge on a properly curved whalebone stem[2] (Fig. 640), or injected by means of the laryngeal syringe[3] (Fig. 641). In the form of vapor produced by the atomizer (Fig. 642), medications of the larynx, together with the other passages, can be effectually made.

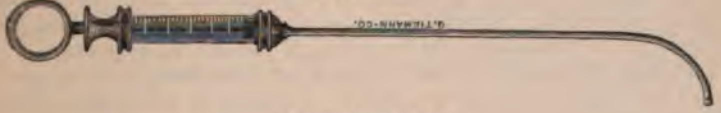
Fig. 640.



Sponge holders.

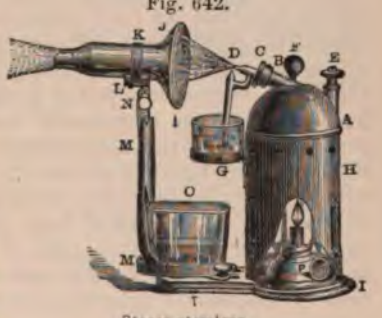
It consists of the sphere-shaped brass boiler A (Fig. 642), steam outlet tube B, with packing-box C, formed to receive rubber packing, through which the atomizing tube D passes, steam-tight, and by means of which tubes of various sizes may be tightly held against any force of steam by screwing down its cover while the packing is warm; the safety-valve E, capable of graduation for high or low pressure by the spring and screw in its top, the non-conducting handle F, by which the boiler may be lifted while hot, the medicament-cup and cup-holder G, the support H, base I I, the glass face-shield J, with oval mouth-piece connected by the elastic band K with the cradle L, whose slotted staff passes into a slot in the shield-stand MM, where it may be fixed at any height or angle required by the mill screw N. The shield-stand is formed into a handle just above the waste-cup O, and its base is formed to receive and hold this cup.

Fig. 641.


G.TIEMANN-CO.

Laryngeal syringe.

Fig. 642.



Steam atomizer.

The following formulæ[4] for the preparation of medicated solutions are useful. The amount of water is one ounce in each case, unless otherwise mentioned:—

Opium, extract, one-fourth of a grain to a grain; tincture, two to twenty drops; camphorated tincture, half a drachm to four drachms; acetate, muriate, and sulphate of morphia, one forty-eighth to one-eighth of a grain. Glycerin, a few drachms to an ounce, undiluted, or diluted with from one to ten parts of water. Table salt, one to twenty grains. Chlorate of potassium, one to fifteen grains. Permanganate of potassium, one-half to five grains. Iron, tr. chloride, one to thirty minims; sulphate, half a grain to ten grains. Alum, one to twenty-four grains. Sulphurous acid, ten to forty minims, undiluted or diluted with from one to ten parts. Tannic acid, one to sixteen grains. Sulphate of zinc, half a grain to ten grains to the ounce of water. Sulphate of copper, one to twenty grains. Tr. iodine, one to twenty drops. Acetate of lead, one to ten grains. Oil of turpentine, one to five drops. Chloride of zinc, one-tenth of a grain to two grains. Carbolic acid one to two grains of the crystallized acid; carbolic acid water, five to ten drops. Infusion of tar, one to four drachms. Nitrate of silver, one-sixth of a grain to ten grains. Corrosive chloride of mercury, one-twelfth of a grain to two grains.

---

[1] L. Elsberg. [2] Granger. [3] A. E. Durham. [4] J. S. Cohen.

Contused wounds of the larynx or trachea may be slight, or may cause shock, or effusion of blood into the connective tissue, or fracture of the thyroid or hyoid cartilage; they are usually vertical; extravasations of blood are frequent. The immediate symptoms may be severe and require tracheotomy; generally the treatment is sufficiently indicated by the symptoms.

Punctured wounds of the larynx or trachea are usually followed by emphysema; if the vocal chords are injured œdema of the glottis is liable to follow. Hemorrhage into the trachea and lungs occurs, and may prove serious. The treatment must be directed towards preventing hemorrhage, and the withdrawal of blood from the trachea; stimulants must be given, if necessary, by rectum.

Incised wounds of the larynx or trachea, such as are inflicted by suicides, though not usually attended by much hemorrhage, are, as a rule, very dangerous, owing to the after-complications liable to occur, as inflammation and œdema about the glottis or in the trachea and bronchi, thickening of the mucous membrane around the wound, or the contraction of the cicatrices; punctured wounds, penetrating between the vocal cords, or injuring one or both, cause œdema about the glottis and suffocation; these wounds do not gape much, unless the cartilage is entirely divided, and hence the free escape of air, blood, mucus, and pus is hindered, and there is a liability to emphysema, and the entrance of matters into the air-passages. First, promptly arrest the hemorrhage, if venous, by continued pressure; if arterial, by ligature or torsion of every bleeding artery; in emergencies it may be necessary to remove clots instantly from the mouth or pharynx, or suck blood from the trachea, or resort to artificial respiration; remove any portion of the epiglottis which may be loose, and if the tongue is divided and impedes respiration, prevent retraction by means of a ligature passed through its tip; when all bleeding is arrested, and there is no immediate hindrance to respiration, approximate the cut surface by placing the patient in bed, with the shoulders raised, the neck and head flexed, and the head fixed by bandages attached to each side of a firm night-cap and fastened to a roller applied around the chest; nether sutures nor adhesive plasters are required, unless the cartilages are cut in several places, and are much separated from each other, when one or more sutures may be passed through the cellular tissue surrounding them.

The patient should remain in a moist and warm atmosphere, and the respiration be carefully watched; if it become obstructed, or emphysema appear, remove the sutures, if present, and search for the cause; if suffocation impends, enlarge the wound and introduce a tracheotomy canula, or make a fresh opening below and insert the canula; if constriction occur from cicatrization, tracheotomy may be required, after which dilatation may be effected with bougies; if fistulæ remain and respiration is not impeded by the closure of the fistulæ, pare the edges and unite them, or transplant skin.[1]

Tracheotomy is recommended in severe injuries of the larynx by some surgeons as a precautionary measure.[2] A rubber tampon canula has been advised.[3]

Internal wounds of the larynx are caused by bones, coins, needles. Pain, cough, expectoration of blood, dyspnœa, aphonia may follow. The laryngoscope may aid in diagnosis. The indications are to allay hemorrhage by ice; remove the foreign body by forceps if it can be detected. If dyspnœa is present, tracheotomy is necessary, and the tampon canula is to be preferred if hemorrhage is liable to occur. The muriate of cocaine may be applied to the throat to enable the surgeon to explore the larynx and trachea.

Fractures of the larynx[1] are of extreme danger, owing to the various obstructions to respiration to which they may give rise by the displacement of the fractured portions, the spasm of the glottis, the entrance of blood into the air-passage, the local or general emphysema, or by inflammation or œdema of the mucous membrane; there is usually flattening of the neck, ecchymosis and emphysema, when the mucous membrane is lacerated; the patient generally suffers great pain, aggravated by pressure and attempts at swallowing or speaking, with lividity, small pulse, convulsive cough, hoarseness, or aphonia; there is mobility of the fragments, and often crepitus is detected; but it must not be mistaken for the roughness elicited on moving the larynx of old people on the cervical spine.[4] The treatment of simple fracture, without dyspnœa, may be limited to external support of the parts with adhesive plaster; but when there is continued dyspnœa from the first, or bloody expectoration, or if suffocation becomes imminent at any period, perform tracheotomy without delay and adjust the displaced parts; retain them in position by suture, or an interlaryngeal splint consisting of an inflated rubber ring.[5]

Thyrotomy[6] is advised for the purpose of treating the wounds antiseptically. Incise the larynx in the middle line, separate the two wings of the thyroid cartilage so as to be able to see the whole interior of the larynx, and apply antiseptic fluid, then plug the interior of the larynx with small pieces of iodoform gauze; the wound should be antiseptic, the fragments of cartilage kept at rest, and the risk of hemorrhage diminished; thyrotomy is justifiable if performed with a view of putting displaced fragments in a better position, and, if the thyroid cartilage be fractured, of uniting the alæ by silver suture. If the fragments of the thyroid cartilage cannot be united, or if stenosis cannot be prevented, extirpation of the partially detached portion of thyroid cartilage is advised;[6] removal of half the larynx has been performed, and a good voice retained.[7]

Dislocation of the cartilages of the larynx may follow blows, or result from internal cicatrices. The arytenoid cartilage is more often displaced from the cricoid Tracheotomy will be required if the glottis is occluded, and cannot be relieved by attempts to adjust the cartilage.

---

[1] A. E. Durham. [2] Witte. [3] Trendelenburg. [4] F. Le G. Clark. [5] L. Elsberg. [6] E. Wagner. [7] T. Billroth.

Foreign bodies entering the larynx are arrested in its interior, or descend, according to their size, form, and weight; when arrested in the larynx, they may lodge in one of the ventricles or become fixed between the vocal chords; occasionally they are arrested at the junction of the larynx and trachea; the first symptoms of the entrance of the body into the air-passages are usually severe and characteristic; the patient gasps for breath, coughs violently, the face becomes livid, the eyes protrude, the body is contorted, and he is like one choked by the hand; if the body is lodged in the larynx, the symptoms will vary with its size and peculiarities; it may be so large as to prove fatal by suffocation, or so small, hard, and smooth as to cause but slight symptoms. Ordinarily there is aphonia, with pain and soreness, and uneasiness in that region ensues, with dyspnœa and whistling sound in respiration; at the same time there is absence of tracheal and bronchial disturbance.[1] If the symptoms are not so urgent as to require immediate tracheotomy, apply a four per cent. solution of cocaine to the palate and pharynx preparatory to laryngoscopic examination; in fifteen minutes examine the larynx; if the body is lodged above or within the larynx, with properly curved forceps it may be seized and removed without pain. As a general rule, the trachea should be opened with as little delay as possible in every case in which a foreign body is certainly known to be retained in any part of the air-passages, for by this means the immediate safety of the patient is secured, and subsequent expulsion or removal aided. An anæsthetic should always be given when the symptoms admit of delay, but in many cases there is not a moment to lose, and the trachea must be opened at once; even if the patient cease to breathe before this is accomplished, the operation should be completed, and artificial respiration instituted and perseveringly maintained. In those cases where the symptoms are so slight as to cause hesitation before adopting such severe treatment, delay is dangerous, for an interval of calm constantly precedes the recurrence of urgent symptoms, and temporary freedom from distress, instead of contra-indicating the operation, affords the best opportunity for its performance.[2] In deciding as to the particular form of operation in any case, it must be borne in mind that while laryngotomy is simple, easy, and free from risk, it is not as applicable to early childhood as tracheotomy, on account of the very limited dimensions of the crico-thyroid space.

Laryngotomy is performed as follows (Fig. 643): Place the patient on a table with the head and shoulders properly elevated and firmly fixed (Fig. 644); feel for the thyroid cartilage at the lower border of which it is to be opened; make an incision with a narrow scalpel along the centre of the larynx, from the top of the thyroid to the base of the cricoid cartilage; this incision will be fully one and a half inches; if the crico-thyroid artery bleed, it must be twisted or tied; divide the crico-thyroid membrane in the same direction in its whole extent; if the opening is not sufficiently large, prolong the incision into the contiguous cartilages or transversely.

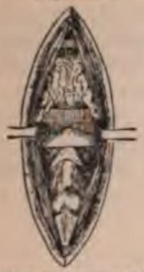
If expulsion should not immediately take place, introduce the double

---

[1] S. D. Gross.

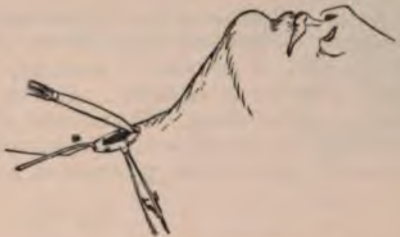
[2] A. E. Durham.

Fig. 643.



Incision in laryngotomy.

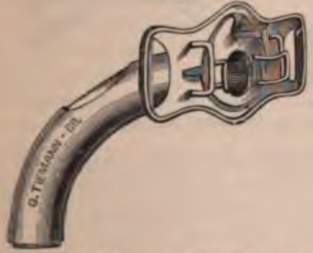
Fig. 644.



Position of patient in laryngotomy.

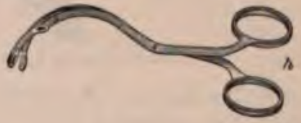
canula (Fig. 645), which secures freedom of respiration and stops hemorrhage; the contracted muscles of the larynx may become relaxed, and the foreign body, set at liberty, be expelled. When the patient has recovered from the immediate effects of the operation, the canula may be removed, and the larynx explored by means of a probe; if the body is not detected, use a larger instrument, as an elastic catheter; the laryngoscope may also be used, and if the foreign body is detected it may be extracted with curved forceps (Fig. 646). If not extracted, the patient may now be safely inverted and the back struck repeated blows, which often dislodges smooth, rounded bodies, as shot, bullets, or pieces of money; if these means all fail, the larynx must be fully exposed.

Fig. 645.



Double tracheal tube, movable plate, silver.

Fig. 646.



Laryngeal forceps.

Thyrotomy, incision of the thyroid cartilage, is not a difficult operation, and does not involve much risk. Place the patient in the position already given (Fig. 644); make the incision through the cartilage perpendicularly upwards from the opening in the cricothyroid membrane previously made, and exactly in the middle line. Make the same search as before, and when the foreign body is removed bring the edges of the incision through the thyroid body together, and secure them by suture; the laryngeal tube may be retained a few days, until all indications of local mischief have passed away.[1]

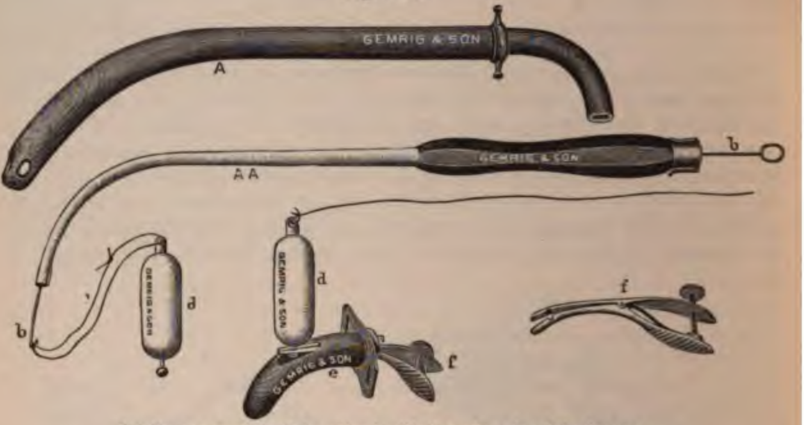
Strictures may require external operations to restore the canal, as in cases of cicatrices after wounds; thus a portion of displaced cricoid cartilage has been removed.

---

[1] A. E. Durham.

Dilatation of the larynx is undertaken when the stenosis is of a permanent character, as in the cicatrization of a wound;[1] in syphilis; after scalds. Dilatation may by undertaken without previous tracheotomy in exceptional cases, but in general an artificial opening below the seat of stricture is necessary, for a canula must be worn until the stricture is relieved. Anæsthesia of the parts by cocaine facilitates manipulation. The method of procedure which has given good results[2] is as follows:[3] Tracheotomy having been performed, accustom the parts to the presence of a catheter or bougie for a few days; then remove the canula daily and insert a catheter through the constriction, allowing it to remain from five minutes to half an hour; when a No. 15 catheter can be tolerated, begin with a series of twenty-four special graduated dilators of smooth, pure tin, shaped to the normal glottis (Fig. 647).

Fig. 647.

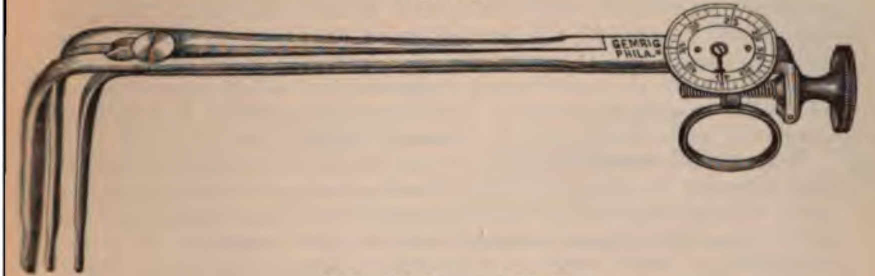


Appliances used by Schroetter in dilating stenosis of the larynx.

These dilators are each four centimetres long, and are graduated in bulk from six to sixteen millimetres; through each passes a rod, having an eye at the top for affixing a thread, and a knot below, or a perforation, by which the bougie can be secured by a pincette, *f*, or by a bolt passed through a fenestrated canula, *e*, in this artificial opening; the bougie is inserted by a canulated director, *A*, *A*, fitted to a perforation surrounding the eyed rod at the top, the thread, *c*, attached to which has previously been drawn through the director by a special wire-hook, *b*, and is then secured to the distal end; when the bougie is secured at the lower end, *e*, the thread is loosened from the director, and that instrument is withdrawn, leaving the bougie in position and the thread hanging from the mouth; the thread is now secured, and the bougie remains in position day and night, until it becomes necessary to cleanse it, or desirable to replace it with a larger one, when it is released below, and withdrawn by traction on the thread; recontraction is prevented by the daily use of curved hard-rubber tubes shaped like bougies at the laryngeal end, *A*, a curved offset being inserted in the protruding part to carry downward the mucus which is coughed out; these tubes are retained in position for from fifteen to twenty minutes, patients being taught to use them. The treatment lasts from six to eighteen months, but may be more rapid.

[1] R. Liston. [2] Schroetter. [3] J. S. Cohen.

Fig. 648.

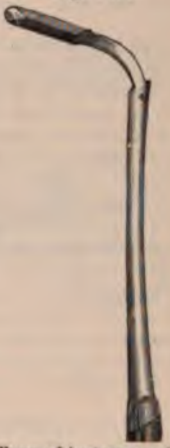


Mackenzie's laryngeal dilator.

Dilators which act rapidly are employed (Fig. 648),[1] but they are liable to create too much irritation.

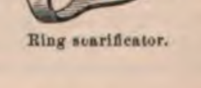
Œdema of the larynx is a serous infiltration of the submucous connective tissue of the upper portions of the larynx; the most frequent seat is in the aryteno-epiglottidean folds, but it may also involve the epiglottis, or involve the lips of the glottis, converting them into thick obstructing pads. It may occur in acute laryngitis, after the inhalation of hot vapors, or the deglutition of hot liquids, or suddenly, in the course of other diseases; but generally the immediate exciting cause is exposure to cold and moisture. The symptoms are marked, and in most cases come on more or less suddenly, and increase in severity with great rapidity; there is a sense of constriction in the throat, difficulty of inspiration, with a stridulous sound, feebleness or hoarseness of voice, dysphagia, and the phenomena of impending suffocation; inspection usually reveals inflammation and infiltration of the structures, but often no evidence of the disease is apparent; exploration with the finger detects the swollen tissues about the epiglottis; the laryngoscope reveals the exact location and extent of the effusion. The sensitiveness of these parts may first be relieved by cocaine. The treatment is prompt incisions into the œdematous tissues. Scarification may be performed with a curved instrument (Fig. 649)[2] having cutting edges, or a ring (Fig. 650)[3] with a cutting point may be used on the end of the right index. If these instruments are not at hand, use a curved hernia knife, or a curved blunt-pointed bistoury, the blade being wrapped with cloth to within an inch of the point. Pass the index finger of the left hand backward over the tongue to the epiglottis; along the finger as a guide, pass the

Fig. 649.



Form of instrument for scarification.

Fig. 650.



Ring scarificator.

---

[1] M. Mackenzie. [2] G. Buck. [3] Grant.

knife, the edge forward, to the posterior part of the epiglottis, and incise the mucous membrane in several places. The tumid folds of membrane are readily felt by the index finger, which serves as a guide to the knife. It is a very simple operation, and usually gives instant relief to the most urgent symptoms; it should be performed even after respiration seems to have been suspended. If dyspnœa continues tracheotomy must be promptly resorted to.

Burns and scalds[1] result from inhalation of flames, hot vapors, and attempts to swallow boiling liquids; violent inflammation follows, with great pain in attempting to swallow, hoarseness, dyspnœa, and croupy symptoms, which gradually become extreme. In a fair proportion of cases little other treatment is required than a warm bed, the application of a hot sponge to the larynx, and the inhalation of warm, moist air; in more severe cases, blisters or leeches are useful; but if the symptoms rapidly progress and laryngeal spasm occurs, tracheotomy must be promptly performed, chloroform being given without fear.[2]

Non-malignant growths, polypi, in the larynx, may be papillomatous, fibrous, sarcomatous, adenomatous, cystic, cartilaginous, and osseous.

The papillomata are far the most frequent; they appear as warty elevations from the mucous membrane, usually of the anterior part of the larynx, near the insertion of the true vocal chords, or from the boundaries of the ventricles, and in some cases from the true vocal chords; they are generally multiple, and sooner or later more or less completely coalesce. The fibrous growths usually spring from the true vocal chords or adjacent parts, are smooth and globular, may be sessile or pedunculated, and do not generally exceed the size of a pea. The adenomatous growth arises from the mucous membrane supplied with glands, as the arytenoid cartilages or folds, or the base of the epiglottis; when sessile, they appear lobulated, and when pedunculated, pyriform. Cystic tumors are rare, and may appear in almost any part of the larynx; cartilaginous and osseous growths have been recorded; mixed tumors may occur, in which the fibrous, fibro-cellular, and glandular elements vary in relative proportion. The condylomata of syphilis, the thickened elevations of phthisis, and the protuberances of localized chronic inflammation, can scarcely be distinguished in some cases from new growths.

The symptoms are, in varying degrees of severity, difficulty of breathing, alteration or extinction of voice, and cough; but the diagnosis is most certainly made with the laryngoscope, or by digital exploration, especially in children. The treatment should be directed to the removal or destruction of all non-malignant new growths as soon as practicable; in some cases it is absolutely necessary, and in others it may be desirable to perform tracheotomy before proceeding to any further operative measures. This question must be determined by the urgency of the symptoms, and the difficulties and dangers of the operation about to be undertaken.

The use of cocaine to the throat facilitates removal. In slight operations where little reflex action and only moderate pain are present use a ten per cent. solution; in more serious operations use a twenty per cent., apply to the pharynx with a mop, and to the larynx with a soft camel's-hair pencil; repeat every minute and a half if necessary as anæsthesia lasts ordinarily only 10 to 15 minutes. Paint all parts with which the instruments will come in contact.

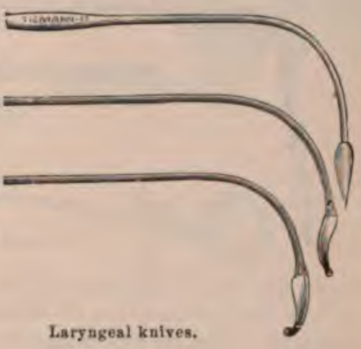
---

[1] A. E. Durham.

[2] T. Bryant.

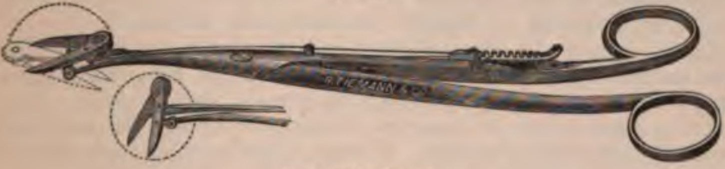
The methods of removal are estimated thus: (1) Caustics are useful in small papillary growths; use the laryngoscope, and apply it with a properly curved caustic-holder. (2) Forceps should be employed to remove small, fibrous, fibroid, fibro-cellular, and papillary growths; the forceps may be of various forms. (3) The wire snare employed is applicable to cases in which the growths are soft and project so that they may be easily caught; the instrument should be properly curved and carry a wire loop.[1] (4) The galvano-caustic is suited to single fibrous tumors with peduncles too strong to allow of their safe removal with forceps; it consists in encircling the growth with a platinum wire, which can be intensely heated by a galvanic battery.[2] (5) The knife (Fig. 651)[3] and scissors (Figs. 652, 653)[4] may be used for the separation of firmly attached growths which cannot be pulled off by the forceps. (6) Puncture is required, in the treatment of cysts, by a curved and

Fig. 651.



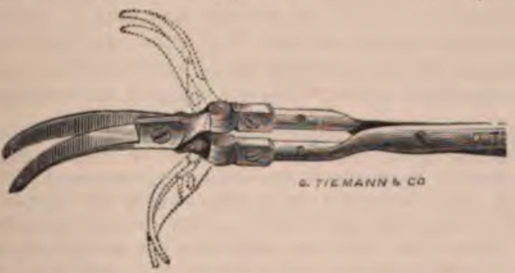
Laryngeal knives.

Fig. 652.



Laryngeal scissors.

Fig. 653.



Laryngeal scissors. (This instrument can be unjointed, and a knife, scissors, or forceps attached, and worked with the same lever.)

---

[1] G. Johnson.

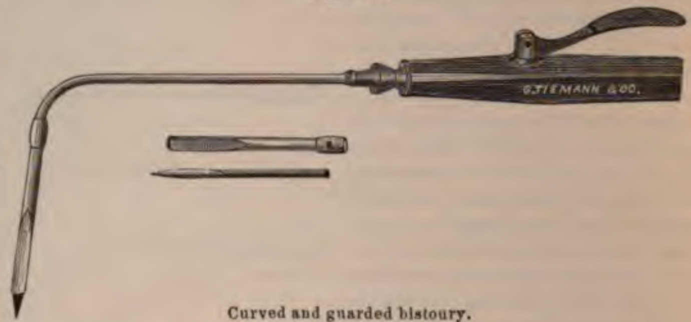
[2] Türck; Bruns.

[3] Tobold.

[4] H. Smith.

arded bistoury (Fig. 654).[1] (7) Thyrotomy is the most certain nd safest method when the growths are numerous or very large, or

Fig. 654.



Curved and guarded bistoury.

single but firmly attached, and when the patient is young and ill able to bear the introduction of instruments through the narrow natural passages. The operation may be performed at once[2] where the growth is small, or, if large, when the removal could be effected by a slight amount of injury to intra-laryngeal structures; but if a great amount of injury is anticipated, it would be safer to facilitate respiration by performing tracheotomy in advance.[3]

Sarcoma of the larynx is rare. The growth is usually single, sessile, firm, smooth, or slightly lobulated, and attains the size of a walnut. It must be diagnosticated with the laryngoscope; it differs from cancer in not involving the glands. If not removed it proves fatal. Removal by laryngectomy has greatly prolonged life. If the tumor is small it may be removed through the mouth, the parts being prepared by cocaine solutions. If large, thyrotomy, or more extended incisions may be required, or even extirpation of the larynx.

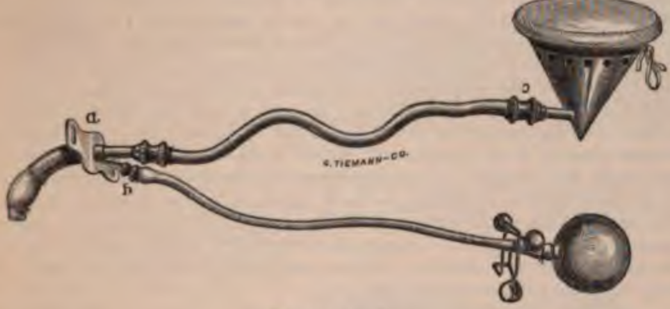
Carcinoma of the larynx is more frequent than sarcoma. It usually begins as an epithelioma, on the pharyngeal aspect of the mucous membrane covering the arytenoid or cricoid cartilages; there is irregular thickening, the surface is grayish, and the edges are elevated.[4] The treatment is extirpation,[5] though the results are not encouraging except in cases which are entirely uncomplicated.

The only special instrument required is the tampon-canula,[6] which consists of an ordinary tracheal canula, over the vertical part of which a ring-shaped rubber balloon is drawn; by means of a rubber tubing connected with it, provided with a stopcock, this contrivance can be inflated with the effect of surrounding the canula with a thick roll and obliterating the space between the canula and the trachea. Before the operation, tracheotomy is performed, the canula inserted into the trachea, and the rubber dilated, thus preventing the escape of blood into the lungs. The rest of the apparatus consists of a tracheal tube with a movable flange, *a*, an ether inhaler, *c*, covered with flannel, attached by a rubber tube to the tracheal portion at *a*; a bag connected at *b*, by a tube, with stopcock, to the rubber dilator, on the tracheal tube, for the purpose of expanding the rubber bag on the tracheal tube, and thus preventing the entrance of blood to the trachea. This instrument has recently been slightly modified[1] (Fig. 655) as follows: The tracheal tube is reduced in length, as also the rubber air dilator, at the extremity of the tube, which now forms a globular shape when inflated.

---

[1] Buck; Mackenzie.
[2] E. Cutter.
[3] J. S. Cohen.
[4] A. E. Durham.
[5] T. Billroth.
[6] F. Trendelenburg.

Fig. 655.



Tampon canula.

The steps of the operation[2] must be determined in each case by the nature of the disease.

Laryngectomy, resection of the larynx, is as follows: All necessary antiseptic preparation being completed, make a single vertical median incision from the hyoid bone to the second ring of the trachea, exposing the front of the larynx; the two sides of the cartilaginous box are then freed from the muscles quite back to the gullet; up to this point the larynx is not opened, and no blood can escape into it; the larynx is then separated from the trachea by a transverse cut, the trachea having been previously transfixed and held forwards with a sharp hook; a large siphon tube of vulcanite, fitting the trachea, is put in, to keep out the blood and permit free respiration; if this is neatly and carefully done, there is no need of preliminary tracheotomy and use of a tampon, which has the disadvantage of largely increasing the length of the wound. If there is much oozing of blood, something may be gained by lowering the head of the patient so that the flow of blood is in the direction away from the trachea; the upper and posterior attachments of the larynx are next cut, care being taken, in separating the gullet and pharynx, to keep the edge of the knife close to the cartilages, so as to avoid button-holing the gullet; it might be well to mop the raw surface out with solution of chloride of zinc, thirty grains to the ounce, at the close of the operation; but it is not advisable to irrigate the wound in any way afterwards, on account of the gulping and irritation which it sets up. Much may be done by keeping the air of the room pure and disinfected. The tracheal tubes should be as large as the trachea will admit, and those made of hard, polished vulcanite are best. When oiled inside and outside with carbolized oil, they are easily changed, and remain clean for a considerable time. The after-treatment requires careful attention to the tube, to avoid any disturbance of the respiration, protection of the lungs from cold or changes liable to cause pneumonia, a uniform temperature of 70° F. and carbolized air, and nourishing diet. Recovery has usually been rapid.

---

[1] G. A. Peters.

[2] D. Foulis.

The last feature in the treatment is the introduction of an artificial vocal apparatus.[1] This must be delayed until the wound is fairly healed and contracted, before which time the apparatus is useless from its small size. The apparatus consists of two tubes, one of which passes into the open trachea, while the other, fitting into the tube, passes upwards to the epiglottis. Into the upper tube slides a silver case containing a plate with a vibrating reed. The anterior opening of the apparatus is closed by a button, and the current of air is directed past the reed, and through the aperture in the tubes. As the upward current impinges on the reed, the latter is thrown into vibrations, and a continuous musical note is produced, which is then modulated into vowels and consonants by the mouth. This instrument has been greatly improved in the power of vocalization by means of reeds made of better metals. It is stated that the articulation of the patient with this apparatus is wonderful; except for the monotomy, it cannot be distinguished from the natural voice; the vowels are perfectly clear and distinct, both in whispering with the reed out and in intoning with the reed in the tube.[2]

Extirpation of larynx, hyoid bone, portion of tongue, pharynx, and œsophagus, may be successfully performed as follows:—[3]

The patient being properly placed and under an anæsthetic, open the trachea and introduce the tampon-canula through which anæsthesia is maintained; make a transverse incision through the skin four-fifths of an inch above the hyoid bone, from the inner edge of one sterno-mastoid muscle to the other; from the centre of this incision carry another in the middle line, over the larynx, close down to the tracheal opening; turn back the two flaps, expose the thyroid cartilage, and extirpate all infiltrated glands, whether lymphatic or submaxillary; divide the mylo-hyoid, digastric, and hyo-glossus muscles, and expose and tie the lingual arteries; now draw the larynx downwards and forwards by a sharp hook fixed in the hyoid bone, and draw the tongue out of the mouth by a ligature passed through the tip; divide the tongue at the proper place, tie the superior thyroid arteries, and cut through the lateral wall of the pharynx, and the pharyngo-palatine arches; expose the external carotid arteries, drawn forwards with the pharynx, tie them in two places, and divide between the ligatures; also, cut the lingual and hypoglossal nerves; the larynx now remains connected only with the trachea, which may be divided just below the cricoid cartilage; dress the wound by first inserting a tracheal canula, protecting the œsophagus, laying the flaps in apposition without sutures, and applying compresses wet with salicylic acid solutions.

Abscess of the larynx, intra- or peri-laryngeal, causes by pressure difficult deglutition, dyspnœa aggravated by horizontal posture, low and hoarse cough. With the laryngoscope intra-laryngeal abscess may be seen, and is attended with much tumefaction of parts. External abscess has the usual symptoms of swelling and finally fluctuation. The abscess should be opened as early as possible.

Stenosis of the larynx may result from acute inflammatory conditions, from syphilis, or from growths. In the first class the symptoms of dyspnœa supervene upon an acute attack of laryngitis as in croup; in the second the dyspnœa comes on very slowly, and the characteristic symptoms of syphilis may be traced; in the third

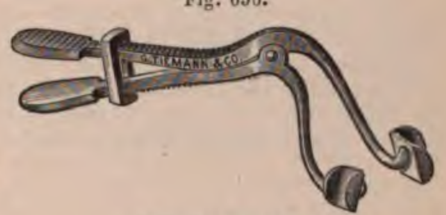
[1] Gussenbauer. [2] D. Foulis. [3] Von Langenbeck.

the growth is seen with the laryngoscope. If dilatations fail the introduction of a tube will be more useful and give entire relief.

Tubage[1] of the glottis; intubation[2] of the larynx, is the insertion of a tube within the larynx, and between the vocal cords for the purpose of relieving impending suffocation from closure of the passage, as in croup, syphilitic affections.

Intubation has proved to be a simple operation and very successful in relieving immediate symptoms. Though the details have not been perfected to the extent that they doubtless will be, yet the results are so favorable as to justify the prediction that in the near future it will be recognized as a legitimate and valuable method of overcoming obstructions in the upper air-passages with a rapidity by no other means obtainable.[2]

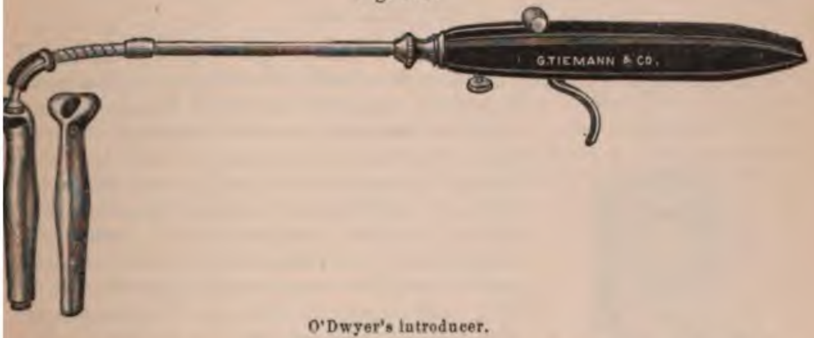
Fig. 656.



O'Dwyer's mouth gag.

The following is the method of introducing the tube, which is done without the use of an anæsthetic:[2] The child is held upright in the arms of a nurse, and the gag inserted in the left angle of the mouth, well back between the teeth and opened widely (Fig. 656); an assistant holds the head thrown somewhat backward, while the operator inserts the index finger of the left hand to elevate the epiglottis and direct the tube into the larynx. The handle of the introducing instrument (Fig. 657) is held close to the patient's chest in the beginning of the operation, and rapidly elevated as the canula approaches the glottis; as soon as the obturator is removed, and it is ascertained with certainty that the tube is in the larynx, the thread which is attached for the purpose of removal, should it be found to have passed into the œsophagus, is withdrawn, but at the same time the finger is kept in contact with the tube to prevent its being also withdrawn; its removal is accomplished in a similar manner; but as it is difficult, on account of the struggling of the child, to

Fig. 657.



O'Dwyer's introducer.

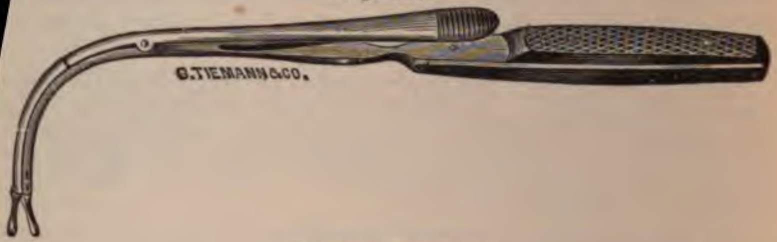
---

[1] Bouchut.

[2] J. O'Dwyer.

ide the extracting instrument into the narrow aperture of the tube, is preferable to give an anæsthetic for this purpose.

Fig. 658.



O'Dwyer's extractor.

The tube is removed by introducing the extractor (Fig. 658) guided by the finger; expanding the points within the tube makes a sufficient grasp upon it for ready extraction.

Bursal tumors, hygromata, occur in the thyro-hyoid regions; (1) in front of the thyroid cartilage; (2) below the hyoid bone; (3) at the root of the tongue; treatment by puncture and injection of iodine, after discharge of the cysts.[1]

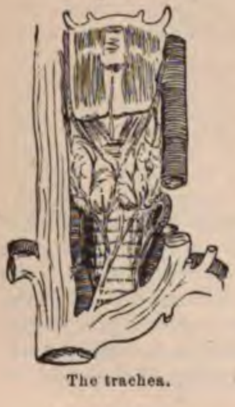
CHAPTER XLIX.

THE TRACHEA; THE THYROID BODY; THE BRONCHI.

I. THE TRACHEA.

THE trachea (Fig. 659) extends from the lower border of the cricoid cartilage of the larynx, on a level with the fifth cervical vertebra, to a point opposite the third dorsal vertebra, where it bifurcates into the two bronchi; it is placed in the middle plane of the body and usually measures from four to four and a half inches in length, and from three-quarters to an inch in breadth, though both the length and breadth vary according to the position of the larynx and the direction of the neck; in the neck and thorax it rests on the œsophagus. The common carotid arteries are situated on either side; the lateral lobes of the thyroid body embrace the upper end and its isthmus crosses just below the larynx.[2]

Fig. 659.



The trachea.

Exploration of the trachea is effected by the same methods as the larynx.

Wounds[3] which divide the trachea are usually attended by considerable hemorrhage,

[1] J. S. Cohen.

[2] Quain's Anat.

[3] A. E. Durham.

as the superior and inferior thyroid arteries, the thyroid veins and the superficial jugulars are liable to injury; the thyroid body and recurrent laryngeal nerves are sometimes implicated. If the tube is partially divided, the edges of the wound gape but slightly and are easily kept in contact; but if it is completely divided, the ends separate widely, the lower being drawn downwards at each inspiration under the neighboring parts and thus impeding respiration. In deep wounds, the œsophagus rarely escapes, and, when injured, materials swallowed pass through the wound. The treatment is, prompt suppression of hemorrhage by pressure of veins and ligation of arteries; approximation of the wound by flexion of the head on the chest, and if the œsophagus is wounded, the passage of a tube by the mouth beyond the divided parts to convey food to the stomach; careful watching throughout to prevent suffocation from the entrance of blood or pus; and the prevention of constriction by granulations.

Obstruction of the larynx and trachea frequently occurs from the lodgment of foreign bodies, or inflammatory effusions within, as in croup, or pressure from without, as tumors. Foreign bodies are not often arrested in the trachea, but descend into the bronchial tubes; if arrested they do not remain long, unless they are sharp and the end becomes implanted in its walls.[1] If the body is light, of small size, with no great irregularity of surface, it may constantly change its position, creating paroxysms of cough with lividity, swollen cheeks, and protruding eyes.[2] The diagnosis depends upon the history of the case, the sudden onset, and peculiarity of the symptoms. Whatever may be the cause of the obstruction, there is often a necessity for immediate relief to the embarrassed respiration: unless the cause is susceptible of prompt removal, the windpipe must be opened at some point. Laryngotomy should, as a rule, be preferred in the adult, and tracheotomy in young children.

Growths of every variety may form in the trachea. They may be benign, sarcomatous, and carcinomatous. They are more frequently found on the membranous portion, and in the upper than the lower division; they are often associated with similar growths in the larynx, bronchi, œsophagus, and with tuberculosis. The symptoms are not marked until the tumor interferes with respiration. Then there are evidences of obstruction, especially in certain positions of the body. The laryngoscope must be relied on to determine the existence, size, and attachments of the growth. Its exact nature cannot be made out except by examination of masses expectorated. The proper treatment of benign neoplasms is incision of the trachea at the seat of the growth and removal with forceps or scissors, and cauterization of the base. Malignant growths admit of only palliative treatment. Excision of the parts involving the trachea have not proved satisfactory.

Tracheotomy may be performed above, through, or below the thyroid isthmus; the latter place gives more room for the canula, and is to be preferred. Provide a firm table covered with several folds of blankets; bichloride solution 1–1000; iodoform and iodoform gauze;

---

[1] S. D. Gross.

[2] A. E. Durham.

carbolized sponges; hot water. Place the patient on the table; elevate the shoulders with a pillow, and support the neck with a firm compress, so as to throw the head backward.

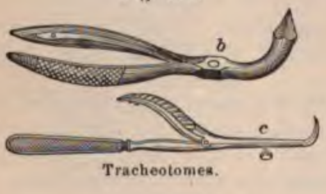
A tracheotomy set consists of the following instruments: A scalpel; two blunt hooks with bulbous ends; catch forceps; two tenacula for holding the wound apart; two tenacula with hooks at right angles with the shaft to transfix and hold the trachea when it is opened; two grooved directors; artery forceps; forceps with fine teeth; the oculist's spring hook to open the wound; tracheotomy tube with two cylinders; pigeon's quills.

If there is immediate danger proceed as follows: The patient being anæsthetized or not, as may be deemed best, and firmly held, the shoulders elevated, and the head extended, stand at his right side and place the forefinger of the left hand on the left side of the trachea, and the thumb on the right side, and make uniform, steady, deep pressure, until the pulsation of both carotid arteries is felt; now slightly approximate the finger and thumb until the trachea is firmly and securely held between them, and maintain this grasp until by repeated cuts in the median line the trachea is exposed; the forefinger of the right hand should be used from time to time to determine the relation of parts; when the trachea is exposed it may be opened at once, or seized by a sharp hook and held while it is opened; make the opening by thrusting the point of the knife (Fig. 644), the edge directed upwards, into the tube, and carrying it upwards to a sufficient extent.[1]

It is important to keep strictly in the median line, otherwise the canula will stand away in the wound, and its extremity will be turned sharply against the membrane of the trachea, and will not only cause irritation, but will quickly become blocked with mucus.[2] The point of the knife must certainly penetrate the mucous membrane, which, if swollen, may be pushed before it; but it must not be thrust too deeply lest it penetrate the posterior wall and the œsophagus; if the first opening is too small, it must be enlarged.[1]

If there is not immediate danger, proceed as follows: the patient being in position, carefully examine the region and determine the precise point of opening the tube; make a straight incision exactly in the median line, extending from just above the cricoid cartilage, nearly as low as the sternum; if the patient has a short, fat neck, make the first incision long enough; the subcutaneous fat and connective tissue being divided, the sterno-hyoid muscles are exposed, divided by a faint line, along which make an incision dividing the fascia; continue the dissection cautiously through the fascia and connective tissue, layer by layer, the separated tissues being held aside, and every bleeding vessel secured until the trachea is exposed and opened.

Fig. 660.



Tracheotomes.

In every case, however apparently hopeless it may have become, the operation should be completed, and the tube introduced, even though the patient has ceased to breathe before this can be accomplished ; the most persevering efforts should be made to effect resuscitation by aid of artificial respiration, and by sucking out the blood that may have entered the trachea, for recovery has repeatedly been effected in cases apparently the most hopeless.[1]

---

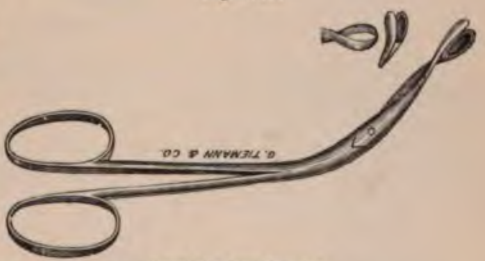
[1] A. E. Durham.

[2] Sir J. Paget.

Various forms of tracheotomes have been contrived to render the operation more easy and less hazardous[2] (Fig. 660), but the use of all such instruments is of doubtful propriety ; the surgeon who is competent to operate does not require anything of the kind, and in the hands of the incompetent they are likely to prove dangerous.[1]

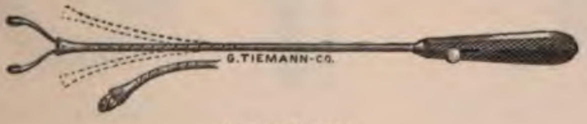
The last stage of the operation varies with the object in view ; if it has been undertaken on account of the presence of a foreign body, the edges of the opening should be held well apart by means of blunt hooks, or dressing forceps, or silk or wire ligatures may be passed through each edge of the wound, and tied behind the neck of the patient ; if the body is comparatively large and impacted in the upper part of the trachea, it is better to introduce a canula into the tracheal wound, and wait until all spasm has had time to subside ; if, however, the body is comparatively small and is situated in the lower part of the trachea, it is better to lose no time in attempting to extract it by means of forceps, lest it find its way into the bronchi.[1] The forceps best adapted to seize the body has a peculiar curve (Fig. 661), with broad beaks. Or, it may have a pliable shaft which can be bent at any curve, and will retain that position (Fig. 662); when introduced it may be closed, and then acts as a probe ; if the foreign body is felt, the blades can be gently protruded, and when they inclose the body be closed upon it, and removal is readily effected. If the operation is undertaken for disease, a canula should be selected which can be worn with comfort, and which will be least liable to obstruction. It should always be double, and so curved as not to press upon the anterior wall of the trachea.

Fig. 661.



Broad beaked forceps.

Fig. 662.



Flexible forceps.

To avoid such results, the external canula should be so shaped as to pass directly backward (Fig. 663), and lie in the middle of the trachea ; it must have a collar, through which the tube is moved by a screw, held in place alar processes, which pass under little wire arches; the inner tube has a joint extremity (Fig. 665) which lies in the trachea, without creating any irritatio To this instrument has been added an obturator[2] (Fig. 664).

---

[1] A. E. Durham.

[2] Von Langenbeck ; Rittna.

Fig. 663.

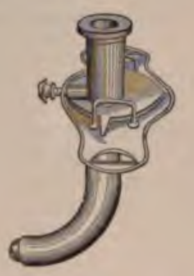


Fig. 664.

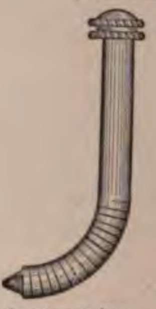
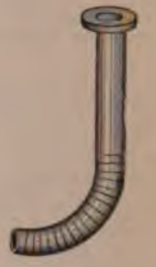


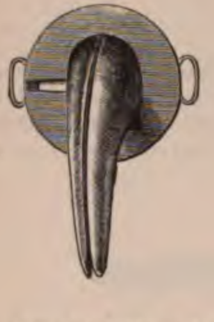
Fig. 665.



Tracheotomy tubes.

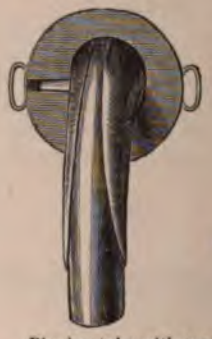
The hard rubber canula is very light and convenient, but does not offer any special advantages. The bivalve canula (Fig. 666) is convenient only in insertion; the two halves forming a wedge along which the canula is afterwards passed. The canula may conceal a hollow trocar (Fig. 668) with which penetration is effected.

Fig. 666.



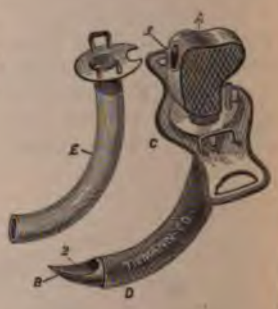
Fuller's bivalve tube closed.

Fig. 667.



Bivalve tube with canula introduced.

Fig. 668.



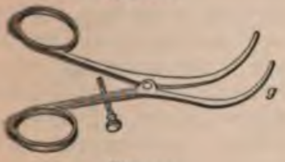
The introduction of the canula is often found to be difficult, and i the effort it may be thrust into the cellular tissue. Various instruments have been invented to aid in effecting it, as guides to the canula as forceps (Fig. 669),[3] or a grooved spatula (Fig. 670),[4] or sma grooved forceps (Fig. 671), or double hooks, worked by a spri (Fig. 672).[5] Practically, it will be found by far the best plan to u the canula mounted upon a blunt pilot trocar (Fig. 673); or an elas catheter or bougie may be used as a substitute.

---

[1] A. E. Durham. [2] G. Johnson. Trousseau.
[4] G. Buck. [5] Von Langenbeck.

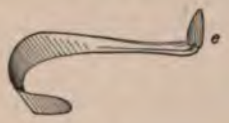
The after-treatment[1] consists in closing the remaining wound with a suture and dusting it with iodoform; maintaining a warm and moist atmosphere; withdrawing the inner tube of the canula, cleaning, and replacing it after it is well oiled; nourishing and sustaining the patient.

Fig. 669.



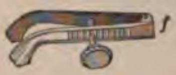
Forceps.

Fig. 670.



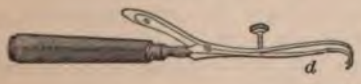
Grooved spatula.

Fig. 671.



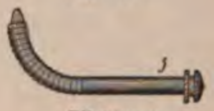
Grooved forceps.

Fig. 672.



Double hooks.

Fig. 673.



Pilot trocar.

In most cases in which tracheotomy has been performed for croup, diphtheria, acute laryngitis, the constant attention of a vigilant and skilful nurse, during a longer or shorter period, is absolutely requisite; the superlative importance of careful watching, judicious management, and unwavering perseverance to the very end cannot be exaggerated.

Croup and diphtheria[2] may reach a point threatening a fatal termination unless relieved by tracheotomy. The value of the operation depends upon the free admission of air to the lungs through the false opening in the trachea, thus relieving the system of the depression due to non-aëration of the blood, and giving to the inflamed tissues a condition of complete rest. Experience teaches that it is generally too long delayed, and yet it is not possible usually to obtain the consent of friends to the operation except as a last resort.

It is neither to be regarded as a routine procedure nor as a last resort; it is a legitimate therapeutic measure, with a definite purpose; the special indications cannot be formulated by an inflexible rule; the good judgment of the surgeon must be his guide; the most favorable moment for interference is when the surgeon begins to think that the patient cannot live without it, but recovery follows occasionally even when the operation has been postponed until immediately after apparent death.[2]

If the exudation is limited to the larynx surgical interference may save life, but if it has descended to the bronchi there is little hope, though cases have recovered under the most unfavorable conditions. It is important to discriminate the symptoms in these two conditions. When the membrane is limited to the larynx and trachea the apnœa is paroxysmal, and very intense; the face is swollen, at first red, but afterwards livid; the eyes are suffused and prominent; the veins of the neck are swollen; the pulse is rapid and small; the head is thrown back; the tissues are drawn inwards beneath the thorax at each inspiration, and later the supra-sternal and clavicular spaces are depressed; the vesicular murmur is slight; inspiration is noisy and brassy; there is great alarm and distress expressed in the face. When such paroxysms occur the danger is imminent and operative interference is necessary. When the exudation is in the large and small bronchi the skin is cold and livid; the respirations rapid; the face swollen; the eyes partially closed; pupils dilated; there is little or no depression of tissues above or below the thorax; the fingers are blue and cold; little air reaches the lungs. An operation in this case is less hopeful but still may relieve somewhat the most urgent symptoms. The most useful remedy in either case is steam, which, to give relief, must saturate the air of the room, the temperature of which must be steadily maintained above 80° F. Two operations may be performed, viz., intubation and tracheotomy. Intubation has been described and bids fair to supersede tracheotomy in croup and diphtheria. At present, however, tracheotomy is very frequently performed, and as the details differ materially from the ordinary operation the following condensed statement will prove useful as it embodies the experience of one of the best authorities:—[1]

---

[1] A. E. Durham.

[2] J. S. Cohen.

Chloroform is the best anæsthetic, but may be dispensed with in extreme cases.

Much as anæsthesia facilitates the execution of the operation it should be avoided whenever practicable, especially in the presence of great obstruction to breathing; recovery is better when it has not been used, and imminent dangers are avoided; it is important to have consciousness retained so that the patient can cough and expectorate voluntarily, or take a deep inspiration when requested.[1]

If an anæsthetic[1] is not given wrap the child in a sheet inclosing the arms and legs to control its movements. One assistant gives the chloroform or holds the head; a second takes charge of the instruments and a third of the sponges. Standing on the right side, the surgeon gently compresses the trachea between the thumb and finger of the left hand and defines the median line. Commencing at the cricoid cartilage he makes an incision through the skin within a third of an inch of the sternum. With hooks the wound is kept open, and he proceeds to cut the tissues down to the trachea, or with the blunt hooks inserted into them, in the median line, he may, by traction in the axis of the trachea, tear through these tissues without hemorrhage. The wound should be frequently wet with sponges moistened in the bichloride solution. Care should be taken not to make lateral traction in order not to draw the trachea to one side. All bleeding vessels should be secured before the trachea is opened.

The dissection may be made on a director introduced under the tissues in the median line, or the operator may seize the tissues on one side with toothed forceps and an assistant do the same on the other side, and making the parts tense the issues are divided in the median line.[1]

---

[1] J. S. Cohen.

The isthmus[1] of the thyroid will be met with, and must be drawn upward or downward according as the opening is made above or below this body. If it is found necessary for any reason to divide it, ligatures should first be passed around it on either side and tightened to prevent hemorrhage when the incision is made through it. The trachea is recognized by its white appearance and its rings. When exposed the connective tissue should be removed from the anterior surface where the opening is to be made so as to prevent emphysema. In opening, steady the trachea with the thumb and fingers, or insert a hook into the upper part and make traction upward in the median line sufficiently strong to steady the tube. The point of the bistoury, or narrow bladed knife, should be introduced between two rings, the cutting edge upward, and three or four rings be divided. Air escapes with a loud hissing sound, and mucus with blood, and perhaps membrane, is expelled. The wound should be drawn apart with hooks or toothed forceps, and the operator should be prepared to seize any protruding membrane which may be loose. The first inspirations may be difficult, but very soon the mucus and shreds are dislodged, and the breathing becomes more tranquil. If there are evidences of the presence of the loosened exudation curved forceps may be introduced cautiously and search made. It is frequently useful to have the patient inhale hot vapor, and sponges moistened with hot water may be held with forceps over the opening. Everything being in readiness, the double canula is gently inserted, and a tape fastened to the rings is tied behind the neck. Though the operation is completed and the patient perhaps is comfortable, the duties of the surgeon are by no means finished. The patient needs constant watching day and night in order to prevent suffocation by the lodgment of exudation in the tube.

Much of the success in tracheotomy[1] for croup and diphtheria depends on the efficiency of the treatment after the operation and subsequent manifestations are completed.[1] The patient should be put to bed in a room at a temperature of not less than 70° F., for a certain amount of chilliness usually ensues, proportionate to the amount of hemorrhage during the operation, and to the intensity of dyspnœa before it; the external opening should be covered with a fold of woollen gauze or scarf, straddled upon a tape or strip of plaster applied above the wound, which protects the trachea from dust, and warms the air a little as it is inhaled; the risk of pneumonia is thereby lessened, and the liability diminished to clogging of the tube by the accumulation of desiccated crusts and fragments of false membrane. The atmosphere of the room should be kept moist as well as warm, by means of steam escaping in the immediate vicinity of the patient, or, if this means be lacking, flat sections of sponge, wrung out of hot water should be kept over the tube; if the reaction from the chill be tardy, warm aromatic drinks should be administered, and flying sinapisms should be applied to the trunk and limbs which will cause restlessness to subside and sleep ensue. Sleep, indeed, often comes on before the dressings are completed, and occasionally on the operating table, as soon as the canula has been inserted; inhalations of steam and the vapor of slaking lime are as useful to detach the pseudo-membrane after the operation as before it, indeed no one agent is probably so useful in detaching false membrane from the larynx and trachea as copious inhalations of the vapors arising from the slaking of lime; we are assured by our experience that the remedy has saved a number of children from undergoing the operation; its action seems altogether mechanical, small particles of lime fraying up the edges of partially detached shreds, so that the watery vapor gets under them and accelerates their separation; a small piece of lime in a pail of water is of no use; several lumps the size of a small fist should be placed in a bucket by the side of the bed, barely covered with hot water; a funnel-shaped hood of newspaper, or a stout paper bag with one corner cut off, should be inverted over the vessel with the outlet directed towards the patient's mouth; in a few minutes there is a copious escape of vapors, charged with lime which rushes through the orifice and is inhaled; the patient's eyes should be protected from particles of lime; cough is excited and sometimes emesis, and with the cough large quantities of false membrane are expelled if any have been present. Each inhalation consumes some ten or twelve minutes, and the process is to be repeated at intervals of half an hour each, or less frequently, according to indications; used in this manner, inhalations of lime, will disappoint expectation much less frequently than the slaking of one small fragment at a time, or the use of lime-water spray.

---

[1] J. Solis Cohen.

Care of the canula[1] is a point of gravest importance, since, as the tube is liable to become obstructed by expectorated products, suffocation will ensue if these are not removed. Hence, a competent attendant—by preference a judicious medical attendant familiar with the character of the accidents which may follow tracheotomy—should be at the side of the patient, or within immediate call, until danger from this source is passed; should the tube become occluded relief must be immediate; the symptoms are the restlessness of the patient and peculiar moist sounds in respiration; the inner tube should then be removed for cleansing and the outer tube should be swabbed out with a feather or a soft mop; these manipulations, as well as the replacement of the inner tube, excite cough and expectoration of occluding products; partial or complete occlusion of the outer orifice with the finger, during the explosive movements of the cough, renders that act more effective; soft antiseptic sponges or mops should be at hand to catch any discharges which may present themselves externally, and to prevent their being sucked back into the canula; a shred of false membrane detained at the inner extremity of the tube produces a characteristic flapping, at times attended with harsh and stridulous respiration; cough is excited and the membrane is usually ejected after some effort; should this expulsion be retarded, the inner tube should be removed, and if the membrane be not driven through the outer one, attempts should be made to catch it with curved forceps; should these fail, cough should be excited by passing a feather or delicate mop through the tube into the trachea; this failing, a few minims of water should be passed drop by drop, and the instillations be repeated at intervals of a few minutes; this failing, aspiration should be made with the catheter and syringe; if all these measures fail to remove the obstruction, the outer canula should be removed, when the membrane will probably be coughed through the unobstructed orifice.

---

[1] J. S. Cohen.

The removal of the canula,[1] especially during the first twenty-four hours, necessitates a skilled hand for its reintroduction; when it cannot be replaced, or its presence prevents expulsion of obstructing products, some other method of keeping the orifice open must be employed, and the dilating retractor, if retractors are employed, will be of great use; hooks may be improvised from hair-pins, and may be held in position by tapes passed around the neck; skilled judgment is necessary for the recognition of these important points, and for their proper management; an officious nurse may interfere unnecessarily on the one hand, and do injury on the other. The obstructed character of the respiration is a guide for interference; under all circumstances the condition of the inner canula should be observed every two or three hours, to clear it of any viscid secretions that may have adhered to it; these should be carefully examined in water, so as to detect membranes, which will float out in flat pieces, their amount indicating how the case is progressing. At the end of twenty-four hours, or thereabouts, the canula, soiled as it is with blood and sputum, should be removed for cleansing, and be replaced by a clean one; it is best to do this by daylight; and with the child in the same position as when it was inserted; this removal is followed by cough and discharge of morbid products; the tube being removed the parts are to be carefully inspected and carefully cleansed; if everything has gone on well, the tube, if of silver, though soiled by mucus, pus, and blood, will not be tarnished; if blackened, mortification is indicated at the corresponding point of the wound; if the tissues are healthy, the parts will be normal in color and soft; and the edges of the wound will be everted; sometimes the parts will be so pliable as to turn inward and occlude the tracheal incision; then a dilator should be introduced to keep the wound open until a tube is inserted; meanwhile, if indicated, search may be made for false membrane; the canula should be changed once a day, and the wound dressed if need be; when air begins to pass by the natural passage, as tested by covering the external wound with the finger-tip, the tube may be left out for a few minutes after each dressing to be replaced immediately should respiration become embarrassed; from day to day the tube may be dispensed with for increasing intervals, until it is finally put aside; one of the most favorable indications for this procedure is expectoration by the mouth.

As the canula exposes the patient to the risk of bronchitis and broncho-pneumonia, it should be removed at the earliest possible period; to determine how necessary the instrument is, close the external opening from time to time, and watch the effects; it should not be withdrawn unless the patient can breathe for some hours with the orifice plugged. The wound usually closes rapidly, after the canula is removed.[1]

II. THE THYROID BODY.

This body is situated in the lower part of the neck, and embraces the front and sides of the upper part of the trachea.

---

[1] J. S. Cohen.

It consists of two lobes, united together towards their lower ends by a transverse portion, the isthmus; each lateral lobe is two inches in length, an inch and a quarter in breadth, and three-quarters of an inch in thickness at its largest part; the direction of each lobe is from below obliquely upwards and backwards, reaching from the fifth or sixth ring of the trachea to the posterior border of the thyroid cartilage; the isthmus is nearly half an inch in breadth, and from a quarter to three-quarters of an inch in depth, and lies across the third and fourth rings of the trachea.[1] In structure, it consists of a framework of connective tissue condensed externally to a more or less thick investing membrane, and traversing the interior of the organ as strong trabeculæ, and of gland vesicles, sustained by the framework, but completely closed and vesicular.[2]

Wounds of the thyroid are followed by hemorrhage; ligate all bleeding arteries, and firmly approximate the edges with sutures and adhesive strips.

Bronchocele, goitre, begins as an hypertrophy of the gland substance or proliferation of the follicular cells; distinctions are based on the relative share taken in the hyperplastic process by other tissues, namely, if the stroma develops, the tumor has a soft consistency; if the connective tissue, it is hard and fibroid; if the arteries, it has a pulsating, aneurismal character; subsequent changes may be attended with the development of colloid matter in the follicles which leads to excessive enlargement, and by its softening causes cysts, or with amyloid and osseous metamorphoses, the former affecting the glandular parenchyma and vessels, and the latter the connective tissue and stroma. The various kinds of bronchocele are, therefore, different stages of development, progressive or retrograde, of the simple hypertrophied gland.[3] The treatment depends upon the variety under observation:—

Simple bronchocele may vary in size, but generally retains the form of the thyroid body, if soft, and is rarely more than an inconvenience; it tends to change by increase of the fibrous stroma; the treatment is iodine, blisters, and iron.[3]

Fibrous bronchocele is smooth, hard, and unyielding, may be small or large, and may involve any or all parts of the gland; the treatment is the passage of a seton through the whole substance of the gland transversely; twine or silk may be used, but twine is preferable, as it produces suppuration more quickly; from six to twelve threads are used.[1]

Cystic bronchocele is generally a blood-cyst and varies in size, being sometimes quite small, but may be so large as to hang down in front of the chest; it most frequently appears in the isthmus, but may occur in any portion; the form is globular, or ovoid, some cysts are movable, others are fixed; fluctuation may be distinct or imperceptible, depending upon the density of the walls. The treatment may be by injections of dilute perchloride of iron in simple cysts; and by incision when the cyst is unusually thick, or contains calcareous deposits, or is constituted in part of gland tissue. Injections are made as follows:[3] Puncture the cyst as near as possible to the median line and at the most dependent portion; as soon as the trocar is felt to pierce the cyst wall, withdraw it and pass the canula deeper by means of a blunt-pointed key; when the fluid is withdrawn, inject a solution of perchloride of iron, ʒij to aqua ℥j; insert a plug and secure the canula in position by a strip of adhesive plaster; repeat the injection at intervals of two or three days until suppuration is established, when the canula should be removed and poultices applied, as in a chronic abscess. Treatment by incision is as follows:[1] Expose the capsule of the gland by an incision either in the middle line or along the anterior border of the sterno-cleido-mastoid muscle, according to the location of the cyst; apply double ligatures to the numerous vessels which are distributed to the cyst and divide them. Should the wall of the cyst be covered, as not infrequently occurs, especially when the sac is deeply seated, by a layer of gland tissue, which may be recognized by its peculiar red tint, this should also be opened without fear of hemorrhage, since its vascular supply has been interfered with by the compression exerted upon it by the cyst. The sac proper having in this way been exposed, carefully enucleate with the fingers, or curved blunt instruments, great care being taken to secure all resisting bands, which are really the vascular connections of the sac, between two catgut ligatures before they are divided with the scissors. The secret of success is the observance of the rule to cut nothing except between the ligatures, and to secure proper drainage under antiseptic dressings.

---

[1] Quain's Anat. [2] E. Verson. [3] M. Mackenzie.

Excision of the thyroid gland is performed by observing the following steps of the operation;[2] place the patient on a firm table, with the head and shoulders elevated and supported, and give the anæsthetic; make an incision, vertically, of ample length, avoiding most sedulously any wounding of the tumor or its fascia propria; divide the successive layers of fascia upon a grooved director until the investment of the tumor is exposed; reflect the investment and enucleate the tumor as rapidly as possible with the fingers and handle of the scalpel, paying no attention to hemorrhage, however profuse, but going as rapidly as possible to the base of the gland and compressing the thyroid arteries by seizing the pedicles with the fingers; transfixion of the pedicle from below upwards with a blunt, curved needle, armed with a double ligature, made of eight strands of saddler's silk, and tying each half, or, when practicable, dividing the pedicle into as many portions as there are main arterial trunks, and tying each portion separately; excision of the gland, firm ligature of all bleeding vessels, and subsequent dressing of the wounds, is as in ordinary cases.

Great care must be taken not to wound the recurrent laryngeal nerve in tying the inferior thyroid artery. Partial excision of the gland has given good results and the portion remaining has not given trouble.

Exophthalmic goitre is characterized by protrusion of the eyeballs, throbbing of the arteries of the neck and head, feeble and rapid pulse, and activity in the bloodvessels of the thyroid body. The patients are usually women who have become weak by loss of blood. The treatment is tonic and hygienic.

Tumors of the thyroid gland may be adenoid or malignant; the former may be enucleated; the latter spread rapidly and must be treated by excision of the gland promptly.

III. THE BRONCHI.

The bronchi commence at the bifurcation of the trachea, opposite the third dorsal vertebra, and diverge to the corresponding lungs; the right is wider but shorter than the left, about an inch in length, and passes almost horizontally into the root of the right lung on a level with the fourth dorsal vertebra; the left is less in diameter, but longer, being nearly two inches in length, and inclines downwards and outwards beneath the arch of the aorta to the root of the lung.[1] The septum, spur, or ridge which separates the bronchi at their origin is not in the median line, but decidedly to the left of it.

---

[1] Kottman; Burckhardt.

[2] W. W. Greene.

Foreign bodies passing through the larynx and trachea generally enter the right bronchus, owing to the peculiar anatomical arrangement at the bifurcation; the symptoms[2] produced, and the obstruction to respiration, depend upon whether the substance is fixed or movable, its size, nature, and precise position; if impacted in one of the bronchi, the entrance of air into the corresponding lung is more or less impeded, or the obstruction may be complete with entire loss of respiratory murmur on the affected side; the body may not occupy the whole calibre of the bronchus, when the vesicular murmur will be diminished; or it may be lodged in one of the primary or secondary divisions, causing an entire absence of the murmur over a certain limited space; natural resonance on percussion is usually preserved; but as a rule the chest rises less, during inspiration, on the affected than on the sound side, and the respiration is peurile in the obstructed lung; fixed pain referred to the upper part of the chest when the body is immovable, or constant pain, with a sense of weight on one side, sometimes indicates the position of the foreign body; the voice may be hoarse, the respiration wheezing, the cough aggravated by deep inspiration; inflammation adds to these symptoms a copious and offensive expectoration, paroxysms of fever, night sweats, and exhaustion.[3] When the symptoms indicate that the foreign body is in one of the bronchi, tracheotomy should be performed, and the opening should be of considerable extent and as low down as possible.[4] The removal may sometimes be effected, if the foreign body is globular, by inversion of the patient and giving the posterior wall of the chest a blow, but care must be taken that the substance does not lodge in the larynx, and cause suffocation. If it is not dislodged it must be extracted by instruments; first explore with a long probe in order to learn the exact position of the body, then introduce suitably curved forceps and seize and remove it.

CHAPTER L.

THE LUNGS.

THESE organs occupy by far the larger part of the cavity of the thorax, and, during life, are always in accurate contact with the internal surface of its wall.

Each lung is attached at a comparatively small part of the inner or median surface by its root; the pleuræ are two independent shut sacs which line the right and left sides of the thoracic cavity; each pleura receives the apex of the corresponding lung, and projects, in the form of a cul-de-sac, through the superior aperture of the thorax into the neck.[1] They extend an inch, and, in some cases, even two inches and upwards, above the margin of the first rib.[2] The right pleura descends to the lower border of the ninth rib, and the left to the lower border of the tenth rib.[3]

---

[1] Quain's Anatomy. [2] J. R. Leaming. [3] A. E. Durham.

Injuries of the thoracic parietes are important only as they affect the contained viscera. These wounds[4] may be simple contused wounds of the soft parietes, contused and lacerated wounds; or accompanied with injury to bones or cartilage; or complicated with lesion of some of the contents of the chest, the pleura remaining unopened, or, if opened, without a superficial wound. In the simpler wounds, in which the soft parietes only are involved, the healing process is often prolonged by the natural movements of the ribs to which the wounded structures are attached, as in cases where balls have taken a circuitous course beneath the skin; the surgeon must be on his guard to watch for pleuritis arising as an occasional consequence of these injuries.

When the force has been great, as when fragments of shell or rifle-balls strike at full speed against a man's breast-plate, not only may troublesome superficial abscesses and sinuses follow, but the lungs may have been compressed and ecchymosed at the time of the injury, and hæmoptysis be one of the symptoms presented. When the projectile has been of large size, although no opening of the parietes or fracture exists, death sometimes ensues by suffocation as the direct result of pulmonary engorgement. The danger of pleuritis or pneumonia will be greater when the injury has been so severe as to cause division of bone or cartilage, and the subsequent suppuration and process of exfoliation will not unfrequently prove very tedious and troublesome. Although the pleura has not been opened, the lung may be lacerated either by the force of contusion or by the edges of the fractured ribs, which may afterwards return to their normal relative positions, so as to leave no indications during life of the means by which the lung had been wounded. Such an injury would be rendered much more probable by the existence of old adhesions, connecting the pulmonary and costal pleuræ opposite to the site of injury. Notwithstanding a projectile has not penetrated the parietes of the chest, a pleural cavity may be opened, as in injuries from other causes, and the lung wounded by the sharp edges of fractured ribs. This will be indicated by emphysema, pneumothorax, hæmoptysis, probably signs of internal hemorrhage, and inflammation. Such wounds will generally be the result of injuries from fragments of shell.[4]

Wounds of the pleura[5] alone are very rare, but their existence has been demonstrated by actual inspection; they must be diagnosed by the absence of symptoms of wound of the lung; the immediate complications which may occur are lodgment of foreign bodies, hæmathorax, emphysema, pneumothorax; the secondary effects may be pleurisy, hydrothorax, empyema, and fistula. In the treatment, all manipulative examination is to be denounced as perfectly unwarrantable, beyond the removal of foreign bodies, the arrest of hemorrhage, and the immediate closure of the external wound; rest and quiet, with low diet, must be enforced, and the symptoms watched to detect the occurrence of complications.

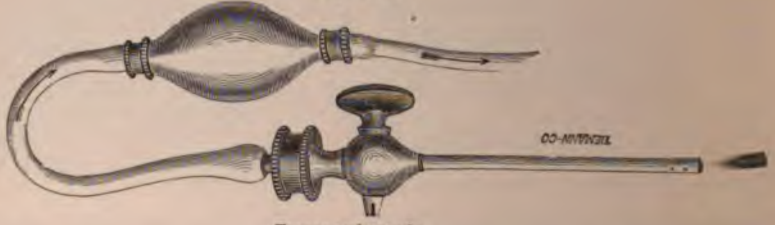
[1] Quain's Anatomy.
[2] C. E. Isaacs.
[3] Luschka.
[4] T. Longmore.
[5] A. Poland.

Foreign bodies lodged in the thoracic cavity may be successfully removed, but antiseptic measures should be persistently employed.

A slug of iron from a bursting gun entered the left chest just below the arm-pit, fracturing the sixth rib, and lodged beneath the heart upon the vertebral column, to the right of the descending aorta. Seventy-four days after, it was removed by the following operation, the patient being extremely prostrated: An incision three inches long was made in the track of the old wound, from the seventh over the sixth and fifth ribs; a transverse incision, three inches long, followed from the middle of the first; portions of the fifth, sixth, and seventh ribs were excised; the pleura was thickened, the lung collapsed, and large quantities of pus were evacuated during the search; the pulsations of the heart were strong against the exploring instrument, and the foreign body was at length detected under that organ, and was removed with forceps; a rapid recovery followed.[1]

Paracentesis thoracis, tapping the pleural cavity to withdraw fluid accumulated in it, is required:[2] (1) In pleurisy, at whatever date, where fluid is so copious as to fill one pleura, and begins to compress the lung of the other side, for in all such cases there is the possibility of sudden and fatal orthopnœa; (2) in double pleurisy, when the total fluid occupies a space equal to half the united dimensions of the two pleural cavities; (3) when the effusion being large, there has been one or more fits of orthopnœa; (4) when the contained fluid is purulent; (5) where a pleuritic effusion, occupying as much as half of one pleural cavity, has existed as long as one month and shows no signs of progressive absorption. The operation should be preceded by an exploratory tapping with a hypodermic syringe to determine the kind of fluid.

Fig. 674.



Trocar and canula.

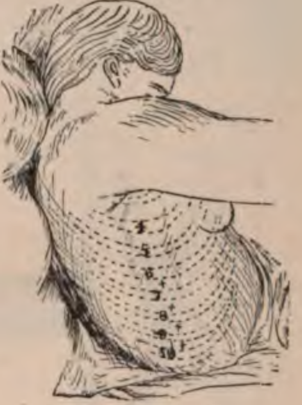
The instrument consists of a trocar and canula[3] (Fig. 674), the latter being fitted to screw upon a flexible suction tube of the syringe;[4] the canula should be provided with a stopcock; the trocar and canula being introduced within the chest, the trocar is withdrawn and the canula attached to the syringe; the liquid is then removed by means of the expansion of the India-rubber suction bag after its compression with the hand. Any form of aspirator may be used, or the common trocar and canula; but in the latter case air must not be allowed to enter unless antiseptic spray is used.

The place of operation will vary within given limits, according to the amount of fluid collected. The indications are, to secure a sufficiently depending position and to avoid wounding the arteries and the diaphragm.[1] In general, the lower portion of the intercostal space must be selected as the intercostal arteries approach the centres of the spaces posterior to the angles, and anterior to the anterior third of the spaces; the upper limit should be the sixth rib, and the lower the eighth rib on the right; and the ninth rib on the left (Fig. 675). The point to be selected when there are no special indications is, the sixth intercostal space on the right, owing to the liver, and the seventh on the left, and midway between the spine and the sternum. Some[2] tap, by preference, below the angle of the scapula and between the seventh and eighth ribs, or the eighth and ninth ribs, at a point distant from two to three inches from the angles.

---

[1] E. S. Cooper. [2] F. E. Anstie. [3] A. Flint. [4] Davidson.

Fig. 675.



Points for tapping.

Operate as follows:[2] Let the patient sit across the bed so as to admit of the body being readily lowered and supported over the edge; carbolize all of the instruments; make a small puncture in the skin, just at the upper edge of the rib, with a narrow-bladed lancet or knife; puncture the cavity through this incision, steadying the trocar with the forefinger of the right hand pressed upon the chest, giving the instrument a slight obliquity upwards, which will enable it to clear the edge of the rib, and a rotary motion; the depth to which the trocar or needle penetrates must depend on the thickness of the parietes, the presence of fat, muscle, or œdema, for which due allowance must be made.

Or, find the inferior limit of the sound lung behind, and tap two inches higher than this on the pleuritic side, at a point in a line let fall perpendicularly from the angle of the scapula; push in the intercostal space here with the point of the finger and plunge the trocar quickly in at the depressed part; be sure to puncture rapidly and to a sufficient depth, to prevent the occlusion of the canula by the false membrane.[3] The amount of fluid withdrawn in any case must depend upon the condition of the patient and the lungs, care always being taken to avoid faintness.[4] When the flow ceases, instantly withdraw the canula, and place the point of the finger on the puncture until adhesive plaster is applied. If the common trocar and canula is used, the outward flow of fluid must not be allowed to intermit, lest air enter the cavity, unless the carbolic spray is in use.

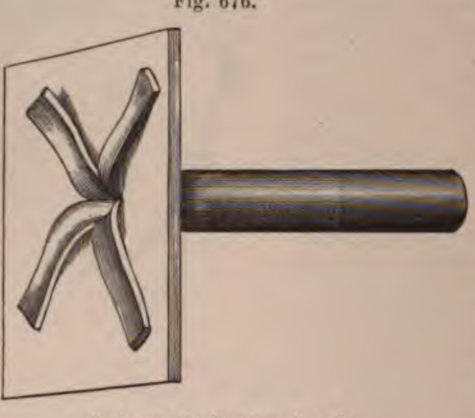
Drainage tubes must be employed if the cavity is filled with pus. Select a trocar and canula of the size of a No. 12 catheter, and rubber tubing No. 10 catheter, having several finestræ cut in the sides, and four inches in length. Cleanse the region of the wound with soap and water and bichloride solution; make an incision through the skin at the point of puncture with the scalpel, and thrust the trocar into the cavity firmly, giving a slight rotary motion to the point; withdraw the trocar and as the pus flows introduce the carbolized tube through the canula into the chest cavity. To prevent its escape the tube must be transfixed with a firm thread which will not soften as silk or salmon-gut, or by wire, and fastened to the chest-walls. Antiseptic dressings should be applied.

---

[1] A. Poland. [2] E. Cock. [3] H. I. Bowditch. [4] T. Watson.

There have been many instances of the escape of the tube into the cavity due to defective fastening, as by safety pins. The following method has been proposed:[1] Cut a round hole in a piece of red India-rubber sheeting one-twelfth of an inch thick, and about one and a half to two inches square; split a tube of the size required, and without holes, at one end into four pieces, and draw it through the hole in the flat piece of rubber, turned down and fixed in position by stitches of fine silver wire. The tube should be just long enough to project into the chest cavity—one and a half to two inches—according to the thickness of the chest wall. Nothing is gained by curling up an enormous length of tubing in the chest. Such a tube adapts itself to a sinus leading in any direction, and requires no special manœuvre to prevent it entering the chest.[2] These tubes can be made in a few minutes, of any size required, by the physician himself.

Fig. 676.



Drainage tube for pleural cavity.

If a tube escape into the cavity proceed as follows:[3] If the case is seen within a short time of the accident, before the position of the tube has been changed by cough or other movement, we may seize the tube with forceps introduced into the wound; if the orifice be too small to admit the forceps, use a sponge-tent or dilator. In using the tent we must bear in mind the possible existence of a bony ridge of union between the ribs in chronic cases, the tract passing through an osseous ring. The attempt to enlarge such a sinus by means of a sea-tangle tent has necessitated the removal of a portion of two ribs.[2] In order to gain the required sense of touch it is advisable to pinch an India-rubber tube with forceps, before blindly searching the cavity.

If we fail after passing forceps of various kinds into the thoracic cavity in different directions, place the patient in the horizontal position, the fistulous opening being most dependent, and then search again with forceps, bent probe, etc.; not succeeding, inject the cavity with water, in the hope that the return stream will carry the tube into the vicinity of the opening. These means proving unsuccessful, enlarge the orifice with a knife so that the finger can be introduced. If the space be still too small, a portion of a rib must be removed in order to accomplish our object. Bear in mind that the adhesions which have occurred between the pulmonary and costal pleura in some cases will probably retain the foreign body in the neighborhood of the fistula, rendering the removal a simple and easy process. The case is apt to be more serious if the affection be recent; adhesions not having had time to form, the tube has probably gained the most dependent portion of the cavity, and will in all probability be ınd in the costo-diaphragmatic sinus. The complication is greater if the ginal incision have been made high up. A second opening in one of the ver intercostal spaces may be required before we can reach the tube in the est.

---

[1] E. B. Baxter. [2] R. J. Godlee. [3] F. Hubner.

Thoracoplastic operation for chronic empyema[1] consists the resection of portions of ribs to enable the chest wall of the scess to come in contact and unite with the lung surface.

Concussion of the lung[2] may result in serious functional de- ngement without organic lesion; it may be transient, and subside thout ulterior results, or it may be succeeded by inflammation, her local or general, of the affected lung. There are no special agnostic signs except, perhaps, the expectoration of blood-stained ucus without pneumonia after the lapse of forty-eight hours. The eatment should aim, (1) to relieve the shock, and (2) then the en- rged lung by leeches over the part, and revulsives.

Wounds of the lung,[3] especially when the projectile lodges, are cessarily exceedingly dangerous. Fatal consequences are to be ıred, either from hemorrhage, leading to exhaustion or suffocation; m inflammation of the pulmonary structure or pleura; from irri- tive fever accompanying profuse discharges; or from fluid accumu- ions in one or both of the pleural sacs. When the chest has been ened by a projectile, the following signs may be expected in addi- n to the external physical evidences of the injury: namely, a certain ıount of constitutional shock; collapse from loss of blood; and, if lung be wounded, effusion into the pleural cavity, hæmoptysis, spnœa, and an exsanguine appearance.

The shock of penetrating wounds of the chest, apart from the collapse conse- ent on hemorrhage, is not generally so great as happens to extensive injuries the extremities or in penetrating wounds of the abdomen. When loss of od occurs without the lung being wounded, the hemorrhage is probably pro- ding from a wound of one of the intercostal arteries, which has been torn by sharp ends of fractured bone. When blood is effused in any large quantity o the pleural sac—as indicated by the exsanguine appearance of the patient, reasing dyspnœa, occasional hæmoptysis, and the stethoscopic signs on aus- tation—the inference is, that the lung has been opened, and that it is from structure the blood is flowing. Hæmoptysis indicates injury to the lung, t does not give assurance that this organ has been penetrated. Dyspnœa is requent accompaniment of wounds penetrating the lung, but not a constant mptom before inflammatory action has set in. When dyspnœa is great in early period, it will often be found to depend upon the injuries to the rietes, and on the pain caused by taking a full respiration. If air and frothy ıcus, with blood, escape by the wound, there can be no doubt of the nature the injury. Emphysema is not common in penetrating gunshot wounds, t occasionally happens.

The treatment must in the first place be the arrest of hemorrhage; terwards the removal of pieces or jagged projections of bone, or ıy other sources of local irritation. Although the shock may hap- n to be considerable, attempts to rally the patient, if any be made, ould be conducted very cautiously; the prolongation of the de- essed condition may be valuable in enabling the injured structures assume the necessary state for preventing hemorrhage. Hemorrhage from vessels belonging to the costal parietes should be arrested by ligature, as in other parts, if the source from which it proceeds can be ascertained, and if the flow of blood be so free as not to be controlled by ordinary styptics. Hemorrhage from the lung itself must be treated on the general principles adopted in all such cases; the application of cold to the chest, perfect quiet, the administration of opium, and, if the patient be sufficiently strong, bleeding from a large opening until syncope intervenes. When blood has accumulated in any large quantity, and the patient is much oppressed, the wound should be enlarged, if necessary, so as, with the assistance of proper position, to facilitate its escape. If the effused blood, from the situation of the wound, cannot be thus evacuated, and the patient be in danger of suffocation, then the performance of paracentesis must be resorted to.

---

[1] A. G. Walter. [2] F. Le G. Clark. [3] T. Longmore.

The extensive bleedings formerly recommended in all penetrating gunshot wounds of the chest are now practised with much greater limitations—indeed, should never be employed simply with a view to prevent mischief from arising. Venesection carried to a great extent does harm by lessening the restorative powers of the frame. To remove splinters of bone, and readjust indented portions of the ribs, the fingers should be introduced into the wound, care being taken that in doing so no pieces of cloth or fragments be separated and projected into the pleural sac. Notice must at the same time be taken of any bleeding vessel requiring to be secured. A pledget of lint should be laid over the wound and a broad bandage placed round the chest, just tight enough to support the ribs and in some degree to restrain their movements, but with an opening over each wound large enough to permit the ready access of the surgeon to it if necessary. If the patient's comfort admits of it, he should be laid with the wound downwards, with a view to prevent accumulation of fluid in the pleura; and if there be two openings, as will be most frequently the case in rifle-ball wounds, one wound should be thus placed, and the upper one kept covered. In gunshot wounds, closure of the parietes by adhesion is of course not to be looked for. If the presence of a ball within the cavity be ascertained, efforts should be made for its removal; but any attempt to determine where the ball has lodged should be made very cautiously, as more harm may result from the interference than from the lodgment of the foreign body.

Pneumocele, hernia of the lung, sometimes occurs. If the protruded portion is uninjured, and healthy in appearance, it may be reduced by moderate manipulation, care being taken not to injure its delicate structure; if reduction is impossible, owing to constriction, and the protruded part is formed of soft structures, the neck may be cautiously divided, care being taken to avoid wounding the lung or intercostal vessels; if the lung is gangrenous, it may be left to slough or an elastic ligature may be applied.

Emphysema, the infiltration of air into the subcutaneous cellular tissue, may occur, recognized by the crepitating feeling under pressure. The treatment is pressure, if it is well borne; puncture and incisions are rarely required. The air may be confined to the cavity of the pleura, pneumothorax. If the oppression of the breathing is very great, open the wound; or, if there is no wound, puncture with a trocar and canula.

Hæmothorax, hemorrhage into the cavity of the pleura, may be so great that death ensues from the loss of blood and pressure on the lungs. The signs of severe hemorrhage are, great oppression, restlessness, sitting up in bed and the body bent forwards, countenance cold and pale; then follow syncope and utter prostration, the patient lying almost motionless; percussion flat; respiration absent. The most judicious treatment is, at first, to close the external wound, and allow the effused blood to coagulate, if possible, with a view to its ultimate absorption. But if the effusion increases, and causes the dangerous symptoms given, the external wound may be kept open or enlarged to allow the escape of the blood by position of the body; or the chest may be opened at a more dependent part; no attempt should be made to pump out the blood, or soften the clot by injection of fluids.

Sarcoma of the lung has been successfully removed.[1] The growth involved a portion of the sixth rib; this was resected; a portion of the size of the fist projected into the chest, and was adherent to the lung, which was separated; a nodule of the size of a walnut discovered in the lung was drawn to the surface and excised with scissors; scarcely any bleeding followed, the wound was closed with catgut sutures, and recovery took place.

Injection of cavities of the lung has been frequently advised,[2] and many times performed with a view to change the character of the secreting surfaces of the cavity. The fluids injected have been five to ten minims of a dilute solution of permanganate of potassa;[3] or sol. carbolic acid and tr. iodine; or Lugol's sol. iodine;[4] or thymol and boracic acid. It is advised[5] to have the fluid, before the injection, brought to the temperature of the body, and to fortify the patient with a stimulant. The following formula has lately been used with apparently favorable results,[5] viz: Atropine, gr. j; morph. sulph., gr. iv; tr. iodine, ʒiij; acid. carbol., pure, gtt. xx; glycerine, ʒiss; diluted alcohol, 20 to 30 per cent., ℥iss. M. Sig. 15 to 30 minims. The value of the treatment of cavities of the lung by injections is at present estimated as follows:—[5]

> The successful treatment of phthisis would include every means, local and general, for checking the accumulation of the tubercular exudation and arresting ulcerative processes, for the system suffers, of course, in proportion to the extent and continuance of suppuration, if not from the actual absorption of the products of ulceration. We observe every day, in the wards of our large hospitals, many patients who, in consequence of a low state of vitality, manifest dangerous tendencies to suppurative disturbances after accidents. The injured tissues decay, and indolent ulcers appear which require lotions or ointments of a stimulating character to induce healing action. The walls of pulmonary cavities are similar to those of indolent ulcers on the external parts in the continuous molecular disintegration of contiguous tissue, and require, it seems reasonable to suppose, direct local treatment. Specialists in every branch of medicine appreciate the value of, and practise local medication in addition to the general treatment of the patient.
>
> Experience[2] in the treatment of pulmonary pus-secreting cavities is very limited; but the past decade has shown, first, that in certain cases incision or paracentesis with drainage is unjustifiable; secondly, that in other cases one of these operations is imperatively demanded; and, thirdly, that there exist other cases in which the question of operative interference is not easy to decide. The first group includes bronchiectatic cavities formed during the progress of pulmonary phthisis. The reported examples in which aspiration and the injection of medicated solutions, and incision with drainage have been resorted to, demonstrate that at the most nothing more than a palliative effect can be expected. In the majority of such cases the time has passed for doing any permanent good, and there is nothing in the operation to stay the resistless march of the disease, or prevent its extension to the adjacent lung-tissue. The second group, or that in which interference is imperatively demanded, comprises suppurating echinococcus cysts, gangrene of the lung, and abscesses from ordinary causes.

---

[1] Krönlain.

[2] Barry; Massy; Hooken.

[3] M. Mosler.

[4] W. Pepper.

[5] J. B. White.

Fourteen cases of cysts have been reported as successfully opened after resecting portions of ribs, the cautery being employed in the soft parts; the parasites well evacuated, a drainage tube inserted, and antiseptic injections used. Gangrene of the lungs has led to puncture of the cavities,[1] and disinfection with great relief. Cavities due to foreign bodies have been opened with benefit. The third group comprises those cases in which the decision of the question of operation is attended with much difficulty. The diagnosis is doubtful, and hence the operation must depend upon the careful study of the conditions present.

The operation is as follows:[2] The long duration of the affection is relied on to form adhesions between the two layers of the pleura at the point selected; an incision is made through the skin and superficial intercostal muscles, along the upper border of the rib; the cavity is now opened with a suitable pair of forceps penetrating more and more deeply into the bottom of the wound; a drainage tube is introduced and fastened to the wall; or, a small trocar canula may be employed; or, a small aspirating needle may be used, with the vacuum formed, attached, especially in the first or exploratory operation. If ribs are over the cavity, portions may be resected.

Pneumotomy, incision of the lung, has been performed for the purpose of opening cavities of the lung. The cavities which are especially adapted to this treatment are comparatively superficial, and the pleural surfaces have become firmly adherent, so that the incision opens directly through the consolidated tissue into its cavity. When these conditions exist the operation has proved useful by the direct drainage of the cavity, and its thorough cleansing and disinfection. Phthisical and broncho-ectatic cavities may be thus treated. Abscesses which result from gangrene, and hydatid tumors, should be treated by incision. Before proceeding to the operation the diagnosis of the exact seat of the cavity, abscess, or tumor, should be made out, and as nearly as possible its precise condition. If the pleural surfaces are adherent the operation consists in dissecting carefully through the tissues to the pleura, and then puncturing with a fine trocar; if pus appears, pass a narrow-bladed knife along the canula to the abscess, and enlarge the opening. A suitable drain should be inserted into the cavity. Through the tube the cavity may be cleansed and medicated. If the pleura is not adherent it is better to insert an aspirating needle, and by that means remove the contents of the abscess or cyst. In time adhesions form in many cases when the abscess may be more freely opened.

Circumscribed collections of pus[3] frequently form in the pleural cavities of children, attended by cough and great emaciation; these cases are often mistaken for pulmonary phthisis, and prove fatal by penetrating the lung, or by exhaustion. The proper treatment is early evacuation of the pus by aspiration, or incision. The abscess being carefully localized by percussion, make an incision and puncture over the upper margin of the rib; the track of the wound may be left open. The relief is usually immediate and recovery prompt.

---

[1] Med. News. [2] C. Hütér. [3] J. L. Smith.

IX.

THE URINARY ORGANS.

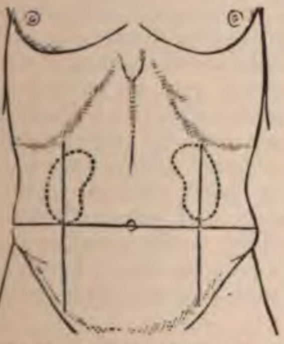
THE KIDNEYS; THE URETERS; THE URINARY BLADDER; THE URETHRA.

CHAPTER LI.

I. THE KIDNEYS.

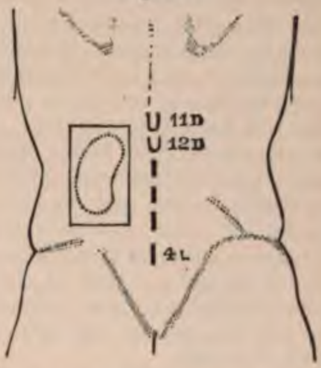
THESE organs lie at the posterior part of the abdomen, on the quadratus lumborum and psoas muscles, opposite the lower dorsal and three upper lumbar vertebræ; the right is a trifle lower than the left, owing to the size of the liver; the pelvis of the kidney is about the level of the spine of the first lumbar vertebra; the upper border is about the level of the space between the eleventh and twelfth dorsal spines; the lower border is as low as the third lumbar spine.

Fig. 677.



Relative position of kidneys to front surface of abdomen.

Fig. 678.



Relative positions of kidneys to posterior surface of body.

A horizontal line through the umbilicus is below the lower edge of each kidney (Fig. 677). A vertical line carried upwards to the costal arch from the middle of Poupart's ligaments has one-third of the kidney to its outer side, and two-thirds to its inner side.[1] Posteriorly it may be bounded as follows:

---

[1] H. Morris.

1, a line parallel with and one inch from the spine between the lower edge of the lip of the spinous process of the eleventh dorsal vertebra and the lower edge of the spinous process of the third lumbar vertebra; 2, a line from the top of this first line outwards at right angles to it for two and three-quarter inches; 3, a line from the lower end of the first transversely outwards for two and three-quarter inches; 4, a line parallel to the first and connecting the outer extremities of the second and third lines (Fig. 678).

During a deep inspiration both kidneys are depressed by the diaphragm nearly half an inch; the healthy kidney cannot be felt by external examination, but the degree of enlargement and tenderness may be determined; care must be taken not to mistake for the kidney an enlarged liver, or spleen, or accumulation of feces in the lumbar colon.

Misplaced kidney[1] may be congenital or acquired; it may be displaced upward, downward, or laterally, or may be rotated upon itself; one is more often displaced than both, and the left much more frequent than the right; it is liable to be mistaken for an abdominal tumor. If the organ is a source of great suffering, nephrectomy will be the only means of relief.

Movable kidney[1] has no mesonephron, but lies behind the peritoneum and on the muscular parietes; it is generally acquired; the range of movement is usually slight, but it may be very great; the right is twelve times more often affected than the left, and it is far more frequent in women than in men.

Frequency has a great share in its production, and a very large proportion of cases occur in women who have borne children quickly or numerously.

The symptoms on the part of the patient are dragging and weight in the loin and side; a sense of something moving; paroxysms of pain like nephritic colic; languor, debility, depression. The physical signs are the presence of a movable body, having the renal outline. The diagnosis depends on the size and outline of the tumor, its ascertainable attachments; want of tendency to increase; sickening pain on pressure, want of resistance in the loin, especially when the patient is on her hands and knees; the facility with which the tumor can be pressed back into the loin. The treatment may be palliative, as avoidance of tight lacing and the application of a truss adapted to make pressure over the kidney when it has been reduced; or radical as nephrorraphy and nephrectomy. The latter operations are only justifiable when palliative measures have failed, and paroxysms of nephritic colic, fainting, sickness, vomiting, and pain radiating far and wide in the course of the branches of the lumbar plexus, occur. Nephrorraphy is to be preferred, except where the kidney is diseased, as the function of the kidney remains, and it is not attended with danger to life.

Floating kidney[1] has a mesonephon which permits it to move more or less freely; it is always congenital, and is associated with elongation of the renal vessels; is excessively rare. The symptoms are nearly the same as are those of movable kidney. The diagnosis must be between floating kidney and other tumors of the abdomen, as ovarian tumors, distended gall-bladder, and movable kidney. The shape of the tumor and its free movements are most characteristic.

---

[1] H. Morris.

The treatment is nephrorraphy or nephrectomy. The former operation should be preferred if the kidney can be replaced. If this operation fail, or cannot be performed, nephrectomy must be a final resort if the symptoms are so severe as to warrant it.

Nephrorraphy[1] consists in stitching the structures about a kidney to the tissues of the loin in order to fix it in position. It is employed in movable, wandering, or floating kidney. The operation of exposing the kidney is the same as for nephrotomy in the loin. The sutures should be strong catgut. In the first cases the suture was passed through the peri-renal adipose tissue, but afterwards through the capsule and the margins of the wound. The suture should be tied so firmly as to fix the kidney in its place. The incision has been made[2] along the outer edge of the quadratus lumborum muscle, and only the peri-renal fat included in the suture at that point successfully.[3]

In 18 cases of nephrorraphy there was one death, a mortality of $5\frac{55}{100}$ per cent. The operation failed to fix the kidney in four of the survivors and in three the success was only partial. Although it has not afforded relief in $43\frac{33}{100}$ per cent. of the cases, its comparative freedom from danger warrants the conclusion that nephrectomy should never be performed for a movable kidney, until mechanical appliances and stitching the organ to the posterior abdominal wall has failed to relieve; the surgeon should select the lumbar incision for safety.[4]

Penetrating wound of the kidney may be recognized by the escape of urine, or by immediate hæmatoma, together with the direction and depth of the wound; the treatment is rest, opium to allay pain, and ergot to arrest hemorrhage. If clots of blood fill the bladder, and cannot be dislodged with hot-water injections, external urethrotomy or lateral cystotomy must be resorted to for relief.

Rupture of the kidney is not necessarily fatal; its severity depends upon its location and extent, for it may involve the external covering, or be entirely internal. When the lesion is confined to the anterior surface, urine may escape, and cause acute and rapidly fatal peritonitis; if limited to the posterior surface, and urine escape into the sub-serous cellular tissue, suppurative inflammation is very liable to be established, with rigors, high fever, typhoid tongue, and œdema of the parts; if the rupture is internal, abscess may occur.[5] Blood may appear in the urine at once or after several days; if a small amount pass with the water, the rupture will not prove serious, for this symptom often follows bruises of the kidneys; but when the hemorrhage is copious and persistent, or recurrent, accompanied with pain, especially if followed by suppuration, the injury is serious. The treatment should be rest; opium, to relieve pain, and quinine, in full doses, if the fever is marked. Fluid extract of ergot in drachm doses every two hours, until four doses have been taken, is very useful, or three grains of ergotin may be injected subcutaneously. Strapping the affected side will often relieve pain and check bleeding. The stomach must be kept quiet by ice and the avoidance of solid food. If coagula form in the bladder or urethra they may escape, but, if they cause much distress, external urethrotomy or lateral cystotomy should be performed. Nephrectomy should be entertained in profuse, continuous hæmaturia, and when from increasing collapse, pallor, and swelling it is apparent that the kidney has been severely injured.

---

[1] E. Hahn.

[2] R. F. Weir.

[3] H. Morris.

[4] S. W. Gross.

[5] J. Birkett.

A constant watch must be maintained of the lumbar and iliac regions to detect the appearance of swelling, in order to be prepared for the early evacuation of pus. A premature opening, in anticipation of the formation of matter, is preferable to delay in giving it vent when once established, for suppuration in the lumbar region spreads rapidly and produces intense constitutional disturbance.[1]

Abscess of the kidney may follow an injury, as rupture, or may result from interstitial nephritis or embolism; the kidney is markedly enlarged; its capsule and the adipose tissue in which it lies are congested and œdematous; beginning as a superficial affection, it no sooner extends to the renal parenchyma than it involves all the connective tissue of the kidney; and this, in turn, culminates in suppuration at various points; the pus may even make its way through a rent in the capsule and lead to the formation of dependent abscesses in the retro-peritoneal connective tissue. The diagnosis[2] of traumatic nephritis rests upon the history of the injury, and the passage at first of blood and afterwards of pus in the urine, to which are added great local tenderness, chills with fever, dull or sharp pains through the part affected, and finally a tumor perceptible on examination.

When the abscess is idiopathic, and no adequate cause can be discovered, the diagnosis is exceedingly difficult, and frequently even impossible, not only in its early stages, but throughout its course; fever, occasional chills, gastric disturbances, vomiting, loss of appetite, and diarrhœa, are often the only objective symptoms; it is only when, in addition to those symptoms, there is tenderness over the region of the kidney, and a tumor can be made out which is evidently connected with that organ, or when rupture of the abscess occurs, that a diagnosis becomes possible.[2]

When the suppuration continues, in spite of well-directed efforts to control its progress, the question of the evacuation of the contents of the abscess, by incision, must be decided.

The following rules[3] defining the conditions under which nephrotomy is not proper, are perfectly good,[4] and should be duly considered: (1) When there is reason to suppose that both kidneys are diseased; (2) when the pus finds free exit by the bladder, no renal tumor exists, and the other kidney is performing its function satisfactorily; (3) when the bladder or prostate are incurably diseased, or grave lesions of other viscera exist.

Evacuate pus by incision in the loin. The opening should be free, and the walls of the abscess should be stitched to the margins of the wound; a drainage tube should be inserted. Even if nephrectomy is performed subsequently, nephrotomy renders the former less dangerous.

Experience proves that the mortality of removal of the kidney for suppurative conditions is nearly twice as great as after nephrotomy, and a preliminary nephrotomy diminishes the risks of nephrectomy by 41.48 per cent. A suppurating kidney should, therefore, never be excised until the failure of nephrotomy, the only inconvenience from which is a permanent sinus or urinary fistula which remains in 29.57 of the recoveries. Either of these may, however, be remedied by subsequent lumbar extirpation of the shrunken sac with the risk of only 9.33 per cent. Of 93 nephrotomies for suppurative lesions, 71 recovered, and 22, or 23.65 per cent., died; while of 73 nephrectomies, 41 recovered, and 32, or 43.97 per cent., died. Of 12 nephrectomies after a previous nephrotomy only 1, or 9.33 per cent., died; while of 61 nephrectomies, without preliminary incision and drainage, 31, or 50.8 per cent., died.[1]

---

[1] F. Le G. Clark.

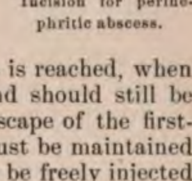
[2] W. Ebstein.

[3] M. Rayer.

[4] Van Buren and Keyes.

Perinephritic abscess may result from injury, abscess of the kidney, or from unknown causes; it consists in the formation of pus in the connective tissue around the kidney. The symptoms are pain in the vicinity of the kidney, rapid pulse, fever, swelling in the lumbar and iliac region, which has a doughy feeling. As the disease progresses, the tumor enlarges, frequently filling up the iliac fossa and protruding under Poupart's ligament or along the edge of the ilium; it may also pass upwards behind the peritoneum, and, penetrating the diaphragm, form connections with the lung, and finally discharge through it, or it may find an outlet for its contents into the bowels, rectum, bladder, or vagina. The early treatment must aim to subdue the inflammation by absolute rest, laxatives, or enemata; leeching, opium to relieve pain, with quinine and nourishing food; auscultation of the lung should be frequently practised, especially in obscure cases, to anticipate any tendency of the pus to find its way out in that direction. Constant attention must be given to the formation of the characteristic enlargement in the lumbar region; when this appears and the nature of the disease becomes manifest, an early operation is demanded; for a premature opening, in anticipation of the formation of matter, is better than that any delay should occur in giving exit to the pus. The point of operation should be, as a rule, in the renal region (Fig. 678), to avoid the peritoneum, and where fluctuation is most distinct, unless the abscess point below, as along the ilium, or at Poupart's ligament; if the swelling is defined, and the abscess shows no sign of pointing, select the margin of the quadratus lumborum, or a point midway between the last rib and ilium, on a line vertical to the centre of the ilium, 1 (Fig. 679); introduce an aspirating needle, and if pus is found, make this the guide to a straight, narrow-bladed knife, and open the swelling freely; if pus is not found, carefully dissect the parts by transverse incisions through the skin, fasciæ, and connective tissue, until the abscess is reached, when it should be opened; if no pus is found, the wound should still be kept open for the purpose of securing the early escape of the first-formed pus. The outflow of pus once secured, must be maintained by tents, if necessary, and carbolized solutions must be freely injected to preserve the abscess from the irritation of retained septic fluids.

Fig. 679.



Incision for perinephritic abscess.

Scrofulous kidney[2] appears in its early stages as a pyelitis, with few marked symptoms, but as it advances there is pain in the loins, tenderness on pressure in the lumbar region, increased area of dulness, and often a tumor can be felt; the urine may not be altered, or may be excessive, and contain albumen, blood, and débris of renal tissue. The diagnosis must be between scrofulous and calculous disease, and the constitutional condition of the patient must determine the former affection.

---

[1] S. W. Gross.

[2] H. Morris.

The chief indications of scrofulous kidney are a poor and weakly physique with existing, or threatening, or part lung symptoms in a person between ten and fifty years old, who is suffering from suppurative pyelitis, with an irregular and occasionally high temperature, and with vesical irritation.

The treatment should at first be palliative. If the disease progress, nephrotomy should be performed with a view to evacuate and drain one or more abscesses in the kidney if the disease is limited. If the kidney is generally involved, or if, after nephrotomy, the disease extend, nephrectomy may be performed.

The kidney has been extirpated for strumous disease twenty times, of which 12 recovered, and 8, or 40 per cent., died; died from exhaustion 3, disease of the opposite kidney 1, from shock 2, from suppression of urine 2. Of 13 operations through the loin 53.84 per cent. died; of 7 ventral operations 14.28 per cent. died.[1]

Tumors of the kidney are of great variety, but there are some general features which are important in diagnosis.[1] 1. The large intestine is usually in front of the tumor, to the inner side on the right, and to the outer side on the left. 2. Tumors do not project or protrude backwards, like abscesses, but expand in front. 3. They have the rounded form and outline of the kidney. 4. They move slightly or not at all in respiration. 5. When the tumor enlarges so as to press the abdominal wall the most anterior point at which it comes in contact is commonly about the level of the umbilicus, or a little higher. There are occasional exceptions to these rules, but rarely to the rounded outline of a renal tumor. Little or no reliance can be placed on the absence of changes in the urine, but pyuria and hematuria are valuable adjuncts, in forming a diagnosis, when present. The size of a renal swelling is estimated as follows: As the patient lies on the back, place the fingers of one hand flat upon the ileo-costal space just outside the erector-spinæ muscles, and those of the other hand flat on the front of the abdomen just over the hand which is behind; during expiration, and whilst the patient's attention is diverted, a very fair idea will be obtained of the size and weight of the organ by depressing in front as much as possible, and tilting forwards those of the hand behind. In thin persons, and by the aid of an anæsthetic this mode of examination is very effective. Extirpation of the kidney is the only remedy.

Cysts of the kidney[2] may be: 1, small and numerous, as in granular disease; 2, conglomerate, or cystic metamorphosis of the kidney; 3, simple or serous cysts; 4, hydatid cysts; 5, paranephric cysts, which are extended to the capsule, but are intimately adherent to the kidney. The presence of a cyst of the kidney is seldom recognized until it has reached a size which makes it detectible externally. Hydatids sometimes discharge by the urethra, and thus reveal the nature of the cyst. The treatment of cysts is puncture and evacuation of their contents; or, if large and especially hydatid, incision in the loin and drainage may finally be necessary. If the kidneys have undergone complete degeneration, nephrectomy may be adopted as a last resort.

---

[1] S. W. Gross.

[2] H. Morris.

The kidney has been removed fifteen times for cysts, with 8 recoveries and 7 deaths, or a mortality of 46.66 per cent.; all the operations but 1 were ventral; the cause of death was peritonitis in 2 cases; shock, infarction of the lungs, secondary hemorrhage, septicæmia, and pyæmia, each in 1 case; nephrotomy in 7 cases by the ventral method, all of which recovered. This operation should always therefore be tried at the outset, unless it be deemed wise to resort first to aspiration. Should nephrectomy, for hydronephrosis, be decided upon, a lumbar operation would be preferable.[1]

Calculus in the kidney[2] is a concretion caused by the deposit of the salts of the urine in the pelvis of that organ.

Renal stones are sometimes found singly, and again in considerable numbers; they vary much in number and size, being generally small, but they may be so large as to adapt themselves to the renal pelvis and calyces, and branch like coral, the number varying according as they include a larger or smaller number of calyces. The greater number of stones pass through the ureter into the bladder, and this is the most common termination of nephrolithiasis; but sometimes a stone becomes so large that it cannot pass the ureter; it then continues to grow, at first filling the renal pelvis partly, afterwards entirely, and sometimes the calyces; the urine secreted above the stone is dammed up in proportion to the amount of hindrance offered to its escape, exercising considerable pressure on the renal tissue, which leads to atrophy of the parenchyma, and sometimes to complete disappearance of the organ, its place being filled by a membranous sac. The presence of renal sand is only learned by proper tests of the urine.

The symptoms caused by larger concretions, though sometimes absent, are usually distinct and often very characteristic. In general, there is pain, sometimes cutting or piercing, in the loins, or attended by a continual sense of pressure or tension. There may be violent paroxysms, renal colic, excited by jarring motions; the pain extends along the ureter and spreads over the abdomen, or radiates to other parts of the body, as the testicle, thigh, breast, shoulder; every movement is torture, and the patient bends double, or lies on the affected side with the knees drawn up; vomiting occurs, and severe strangury, the urine being scanty, red, brown, or blackish, or loaded with blood, mingled with pus and mucus. The diagnosis rests upon those symptoms pointing directly to the kidney involved, and the behavior of the urinary secretion during an attack. The treatment should be directed (1) to prevent the formation of renal sand and gravel, and (2) to remove the already formed precipitates. As a rich or exclusively flesh diet promotes the formation of renal sand, especially uric acid, simple and easily digestible foods should be substituted, with active out-of-door exercise. The medical remedies of greatest value are alkalies and alkaline salts, as the bicarbonate of soda, carbonate of potash, carbonate of lithia, or the mineral waters of Vichy; they must not be taken in such quantities as to render the urine alkaline; otherwise earthy phosphates will be precipitated. If, however, the concretion forms in the kidney, efforts must be made to relieve its effects. The paroxysms of pain must be relieved by opium or its salts; the hypodermic injection of morphia is generally most serviceable; an enema of laudanum is often useful, with anodyne applications. Extreme heat, as a very hot brick, heated sand, or salt bag, or bottle of boiling water, well wrapped, is very soothing; an anæsthetic may occasionally be necessary; chloral, with morphia, sometimes acts very favorably. Should the presence of the stone cause suppuration, with a well-defined tumor, the pus must be early evacuated, at first by aspiration, and then by incision, as in the case of perinephritic abscess. But the still more important operation of nephrotomy, incision of the kidney for the removal of the stone, must now be duly considered, and even extirpation of the kidney may become justifiable

---

[1] S. W. Gross.

[2] W. Ebstein.

When the symptoms point to a renal calculus the surgeon should make an exploratory operation through the loin, with a view to its detection and removal without a resort to nephrectomy.

Of 234 exploratory operations all recovered, though the kidney was incised in 4.

When the organ is not dilated by pus or urine, its secreting power not being materially damaged, the operation should be nephro-lithotomy, but under no circumstances should any but the lumbar incision be resorted to, unless there is doubt as to which kidney is involved.

Of 21 cases of nephrolithotomy 2, or 9.52 per cent., died. Of 23 exploratory operations all recovered, though the kidney was incised in four.

Fistulæ of the kidney[1] results from wounds of the kidney or ureter, which may be shot, stab, or a surgical operation. Abscess of kidney relieved by nephrotomy is very liable to be followed by fistula. Obstruction of the ureter by calculi have been followed by fistulæ. The treatment should be such measures as will tend to close the fistula, viz., caustics, injection of iodine, or dissection of the indurated tissues, and closure of the sinus by suture. If these measures fail, and the fistula is a source of great annoyance, the question of nephrectomy must be considered. The operation is proper if the other kidney is healthy.

Hydronephrosis[2] consists of a dilatation of the pelvis of the kidney and subsequent more or less extensive disappearance of the renal parenchyma, due to obstacles to the escape of the urine in any division of the urinary passages; it may be congenital and non-congenital, the former being due to malformations, and the latter to concretions wedged into the pelvis or the ureter, or pressure from various causes upon the urinary track. The symptoms depend upon the grade of distension, and the invasion of one or both kidneys; if the obstruction is considerable, and especially if both organs are involved, the symptoms are those of embarrassed, diminished, or arrested activity of the kidneys, namely, acute or chronic uræmia. The tumor caused by distension of the kidneys may attain a very large size, is generally unilateral, and occupies the loins, extending to the vertebral column, and often upwards into the hypochondrium, downwards into the iliac region, and forward to the umbilicus; it is soft, dull on percussion, distinctly defined by palpation, gives a distinct sense of fluctuation, is not movable, generally painless, and causes no feeling of inconvenience except that of weight and tension; if caused by nephrolithiasis, there will be attacks of renal colic with bloody urine. The disease may be diagnosed from ovarian cysts by rectal examination with the hand, and from other tumors by the method of exclusion. The treatment in the early stages is expectant; where, however, the tumor is large and effects the health, as by embarrassing respiration, it may become necessary to remove the fluid; this has been effected by repeated kneading of the tumor, which resulted in the escape of a large quantity of urine, and apparent recovery.[1] Usually evacuation is best effected by aspiration, but the operation is not free from danger.

---

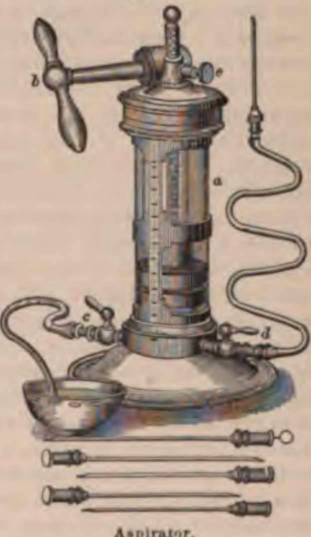
[1] H. Morris.

[2] W. Ebstein.

The aspirator is designed to remove fluids from cavities by means of capillary tubes and a suction-pump, so as not to leave an open wound nor admit air to the cavity. Various forms of aspirators are now in use which answer every purpose, but none are as thoroughly effective as that originally introduced into practice (Fig. 680).[2]

In using the instrument the cocks *c d* are closed, and the handle *b* turned, producing a nearly perfect vacuum in the cylinder: the piston is held in raised position by a spring, *e*. The trocar is introduced with a rotary motion into the part from which the fluid is to be withdrawn; on opening the cock *d* it flows into the cylinder, which is emptied when full by closing *d*, opening *c*, pulling out the spring *e*, and lowering the piston; when this is done both cocks are again closed, and the operation repeated.

Fig. 680.



Aspirator.

The point selected for aspiration will depend upon the size and form of the tumor. In general the space between the eleventh and twelfth ribs on the left side gives the most direct access to the cavity of the tumor, and is least liable to involve the peritoneum. When the tumor is on the right kidney the best spot to select, if there be no indication for operating elsewhere, is half way between the last rib and the crest of the ilium, between two inches and two inches and a half behind the anterior superior spine of the ilium; the trocar should be directed somewhat forward. Nephrotomy is the proper operation for cases in which aspiration has failed and which need further treatment.

---

[1] Roberts.

[2] M. Dieulafoy.

Of 21 cases of nephrectomy for hydronephrosis 13 recovered and 8 died, the deaths being 38.09 per cent. Of these 17 were neutral operations, 10 recovered and 7, or 41.17 per cent., died; 4 were lumbar operations, 3 recovered, and 1, or 25 per cent., died. The cause of death was shock in 3, peritonitis in 2, and septic peritonitis in 2, and anuria from disease of the opposite kidney in 1. Incision with drainage of hydronephrotic kidneys has been practised in 25 cases; 21 recovered and 4, or 16 per cent., died. Of 14 ventral incisions 11 recovered and 3, or 21.42 per cent., died; while of 11 lumbar incisions 10 recovered and 1, or 9.09 per cent., died. Of the 20 survivors urinary fistulæ persist in 11, or 55 per cent. In fifteen cases of puncture for hydronephrosis there were 12 deaths, 1 cure, and 2 temporary improvements; of 5 cases of injection with tincture of iodine 3 died and 2 were cured, hence further efforts in these directions should be abandoned. Of 6 instances of aspiration, 3 were cured, 2 improved, and 1 died of a cause not connected with the operation. From these facts it appears that aspiration is a perfectly safe procedure; that lumbar nephrotomy yields fewer deaths by 15.91 per cent. than does lumbar nephrectomy, and that the latter operation is safer by 16.17 per cent. than is the ventral operation. Hence, in cases of hydronephrosis, lumbar aspiration repeated, if it be necessary, several times should first be resorted to; in the event of its failure, nephrotomy should be practised; if a fistula result the kidney may be removed through the loin.[1]

Nephrotomy, section of the kidney, is performed as follows:[2] The incision is precisely the same as for lumbar colotomy, except that as the kidney is situated a little nearer the median line than the colon, the deep part of the wound should be kept a little posterior to that of colotomy; make a slight oblique incision in the costo-iliac interspace, begin over the outer edge of the erector spinæ muscle, and continue it forward for three and a half inches; after dividing the skin, superficial fat, and fascia, the outer border of the latissimus dorsi, and the posterior border of the external oblique of the abdomen will be brought into view, and should be divided to the full extent of the superficial incision. It is unnecessary to open the sheath of the erector spinæ. Next, cut through the internal oblique and the aponeurosis of the transversalis, whereupon the outer border of the quadratus lumborum will be seen, and a deep layer of the lumber aponeurosis must then be divided. No grooved director or other guide will have been necessary up to this stage. A scalpel and a pair of dissecting forceps for the operator, and two well-formed deep retractors for the assistant being all the instruments required, beyond two or more pairs of torso-pressure forceps to control hemorrhage from any vessels cut in the division of the parietes. The peri-renal fatty tissue, having thus been reached, will in all probability be found condensed, and otherwise much altered, from the inflammatory process which has gone on in and around the kidney; and if the operation be done for abscess of the kidney, suppurative changes, perhaps, will have taken place in the structure forming the bed of the organ. When this tissue has been divided, the distended pelvis, cyst, or abscess (as the case may be) of the kidney should be either first tapped, or at once cut into, its contents evacuated, and the cavity well irrigated with some disinfecting solution. If it be thought desirable, as it is in hydronephrosis and cyst of the kidney, to stitch the cut edges of the cyst to the edges of the skin, it should now be carefully done. Drainage and antiseptic irrigation must be secured by means of a rubber tube fixed in the wound through which weak carbolic acid or bichloride solutions are passed daily Recovery usually takes place, but if a fistula remains, and the character of the fluid is purulent or offensive, it is proof that what remains of the renal tissue is incapable of performing the proper function of the kidney; the patient runs risks from the continuance of the sinus, and cannot derive any benefit from retaining such a useless remnant of a kidney. Lumbar nephrectomy should now be performed.

---

[1] S. W. Gross.

[2] H. Morris.

The dangers of the operation depend entirely upon the condition of kidney for which the opening is made.[1]

Nephrolithotomy, section of the kidney for stone, is performed as follows:[1] Make an incision four and a half inches long, parallel with and three-fourths of an inch below the last rib; divide the structures as in nephrotomy. If the quadratus lumborum be so wide as to contract the deep part of the wound, incise its outer edge to the extent of one-half or three-quarters of an inch. Arrest bleeding, and while an assistant stretches the edges of the wound wide apart with suitable retractors, with two pairs of forceps tear through the peri-renal fat.

In approaching the back of the kidney there will sometimes be noticed a difference in the character of this fat, that in immediate contact with the kidney being of finer texture and of a delicate primrose color; this appearance will not be expected if there has been inflammation in the tissues around the kidney, and the whole of the tissue will probably be dense and tough.

The kidney having been reached, pass the index-finger carefully over the whole posterior surface of the organ, including the pelvis, and search for any inequality of surface, or increased hardness, or resistance at any particular point. During the examination of the kidney the abdominal walls should be well supported by an assistant or pillows, in order that the kidney may not be pushed forwards by the finger. If nothing is discovered suggestive of a stone, introduce a fine needle into the renal substance, so as to explore the calyces where the stone usually rests; if one spot gives more resistance than another, puncture it first. If this exploration fail, pass the fingers of the right hand round the outer edge of the kidney, and feel over the front surface, squeezing the organ between the thumb and finger, or pressing it against the psoas muscle.

Despite all of these precautions a stone may escape detection; the kidney becomes very hard and tough under the prolonged irritation of a stone, so that whilst it feels firmer than natural, any slight difference in the degree of resistance of one part is more difficult to appreciate; this hardness of the renal substance is sufficiently suspicious of a calculus to encourage the surgeon to open each of the calyces by incision.

The stone having been detected, incise the kidney with a probe-ended straight bistoury, and with the finger introduced through the incision raise the stone to the surface of the parietal wound; or a pair of forceps may be passed by the side of the knife and the stone

---

H. Morris.

seized. The secreting structure should be opened in preference to the pelvis to avoid the liability to a urinary fistula. If the stone is large and branched, it must be broken before removal. The dressings consist of a drainage-tube in the back part of the wound, and closure of the remainder by sutures; lint spread with boracic ointment or soaked in terebene and oil should be applied over the wound, and the drain-tube passed through this and covered with absorbent cotton-wool or carbolized gauze. The urine flows through the wound at first, but gradually ceases, and disappears altogether in three or four weeks.

Nephrectomy,[1] excision of the kidney, may be performed in the lumbar or abdominal region.

(*a*) Lumbar nephrectomy[2] should be performed in cases in which the removal of a disorganized kidney is advisable, after nephrotomy has been tried and failed to improve the condition of the patient; in nephrolithiasis for which nephrolithotomy is not practicable; in uretal urinary fistulæ; in wounded and ruptured kidney past the probability of functional repair, or in which blood-clots are being forced into the ureter, and plug it so as to lead to urinary extravasation into the loin, or to acute nephritis of the injured organ and threatened implication of the peritoneum; in renal cystic tumors, in small or medium sized solid tumors of the kidney; and for some painful movable kidneys, condemned to removal. Operate as follows: Make a transverse or slightly oblique incision as in nephrotomy, and somewhat nearer the last rib than in lumbar colotomy; with this should be conjoined a second incision running longitudinally downwards from the first and starting from it about one inch in front of its posterior extremity. The first incision should be about four and a half inches in length, and not nearer the twelfth rib than half an inch for fear of wounding the pleura, which sometimes descends a little below it. The second incision may be left until the kidney has been reached and explored, and can then be made by cutting from within outwards with a probe-ended bistoury steadied by the index finger of the left hand. The kidney being reached, separate it from its surroundings; when no peri-renal inflammation has existed, the colon, peritoneum, and fatty tissue will easily be detached from their connection with the kidney by the index finger of one hand worked close against the capsule of the organ.

It will generally be found that even when no inflammation has occurred, some of the renal capsule will be torn off and left behind, and in other cases, as when the operation is performed for calculous or scrofulous pyonephrosis, and as a subsequent proceeding to nephrotomy, the kidney should be enucleated from its thickened and adherent capsule, which should be left behind with the pedicle.

A double ligature of plaited silk is next passed through the pedicle between the ureter and the vessels, by means of an aneurism-needle fixed in a long handle whilst the kidney is dragged well up into the wound by the operator's left hand, one of the fingers of which can at the same time be acting as a guide for the needle; the needle passed and withdrawn divide the ligature silk, and tie one-half tightly around the vessels, and the other half around the ureter, pressing the ligatures well inwards towards the front of the spine so as to leave plenty of room between them and the hilus for dividing the pedicle. Now draw the kidney quite out of the wound, aiding the manœuvre by dragging the lower ribs forcibly upwards with the fingers of the left hand dipped into the wound. Another ligature should be thrown around the whole of the pedicle, and securely and tightly tied before cutting the kidney free, which is now safely done by snipping through the ureter and vessels with a pair of blunt-ended scissors. All bleeding vessels should be securely tied, and all of the ligatures cut off short, and the pedicle dropped into the wound. A drainage tube should be inserted, the edges brought together with waxed silk, or fishing-gut sutures, and antiseptic external dressings applied. The patient should be kept in the recumbent position until healing is complete, and the drainage should be kept up for four or five days; healing is as a rule rapid, though the drainage track will require from three to four weeks to close perfectly, and it is well that during all this time complete quietude should be observed, and great care given to the diet, so that the other kidney may not be irritated by too great concentration of urine.

---

[1] G. Simon.

[2] H. Morris.

Some surgeons attach importance to the separate ligature of the artery, vein, and ureter; others think it is unnecessary to ligature the ureter; others that the ureter should be stitched to the external wound. The most important thing, however, is to securely control the vessels without putting too great a strain upon them in doing so. To attempt in all cases to get the kidney to the surface before ligaturing the vessels would be to run a great risk of lacerating the coats of the artery or vein beyond the point at which it is possible to apply a ligature. In no case is it advisable to excise the last rib, and where the costo-iliac space is very narrow, some other form of operation, not the lumbar, should be adopted. The dangers of the lumbar operation are that the peritoneum or the colon may be torn open; or too great strain on the vessels of the pedicle may cause their laceration, or the ligatures may slip after the kidney has been cut off; or the kidney may be broken in the manipulations required for its separation and withdrawal.

(*b*) Abdominal nephrectomy[1] is preferred in cases of large tumors, and of all wandering kidneys very loosely held by a mesonephron. Operate as follows: Make an incision along the outer border of the rectus abdominis muscle on the side of the kidney to be removed; the middle point will probably correspond with the umbilicus, but this will depend upon the size and outline of the tumor. All bleeding being arrested, open the peritoneal cavity, and first ascertain the presence and condition of the opposite kidney. Keep the intestines aside from the kidney to be removed by a flat aseptic sponge introduced into the abdomen. Now, open the outer layer of the meso-colon sufficiently to allow of the introduction of two or three fingers behind the peritoneum and into the fat in front of the kidney, and the fingers should then gently tease their way towards the renal vessels around which ligatures should be secured; if the vessels are tied separately, tie the artery before the vein; the ureter should be seized by two pairs of ovariotomy forceps and divided between them. Next enucleate the tumor, divide the vessels outside the ligatures, and remove the mass. The ureter should be tied with ligature silk. The operation is completed as an ovariotomy and the subsequent treatment is the same.

---

[1] M. Morris.

The conclusion[1] pointed out by statistics is that, though in many cases, from the size of the tumors, the abdominal operation is easier, and therefore better, yet that the lumbar method is, as a rule much safer, and should be preferred in all cases in which the kidney is not much enlarged, the tumor can be reduced by puncture, and in which the loin space is not too much contracted.

Sarcoma of the kidney occurs more often in infants and young children. They grow rapidly, and soon form a tumor which distends the loin. They may be painless or attended with aching, owing to the pressure which they exert upon surrounding organs. The only treatment is excision of the kidney.

Kidneys have been removed for sarcoma 33 times, with 14 recoveries and 19 deaths, a mortality of 57.57 per cent. Of 26 ventral operations, 11 recovered, 15, or 57.69 per cent., died; of 7 lumbar operations, 3 recovered, 11, or 57.14 per cent. died. The causes of death were shock in 7, hemorrhage in 3, septic peritonitis in 3, septicæmia in 2, exhaustion 2, pulmonary embolism 1, tetanus 1. As regards the ages of the patients it is concluded that nephrectomy for sarcoma in children should not be repeated, but that in adults it is justifiable.[2]

Carcinoma of the kidney[1] begins either in the fibrous stroma of the cortex or in the epithelium of the renal tubes; frequently the proper tissue of the kidney is invaded by a cancer which has had its primary seat in the lymphatic glands or other structures about the hilum. The most constant symptom is the presence of a tumor in the loin, which, as a rule, is painless, until by its increase it presses upon surrounding structures when the pain radiates far and wide; œdema, constipation, and vomiting are frequently present, and also jaundice, if the right kidney is affected. The rapidity of the growth, its unequal resistance and nodular outline, and progressively cachectic appearance of the patient point to cancer. Irritability of the bladder and hæmaturia are late symptoms. The treatment should be palliative.

From the following *résumé* of operations it is concluded that carcinoma of the kidney should be excluded from the category of cases for which nephrectomy should be done: In 14 cases of removal of the kidneys for cancer, 4 recovered, and 10, or 71.42 per cent., died; 9 were abdominal sections, and 8 died; 4 were lumbar operations, and 1 died; unknown 1. Of the 4 survivors 2 died of secondary growths, 1 in 44 days, 1 in two months, 1 was living at the end of 2 months, and 1 at the end of 13 months.[2]

II. THE URETER.

The ureter, dilated at its upper end as it approaches the hilus, expands within the sinus into a funnel-shaped cavity, compressed from before backwards; within the sinus the pelvis divides usually into three, or sometimes only two, principal tubes.

---

[1] M. Morris.

[2] S. W. Gross.

It is 14 to 16 inches in length; as it passes downwards and inwards to the brim of the pelvis, it lies immediately behind the peritoneum. At the base of the bladder, they are about two inches apart; they enter the coats of the bladder and run obliquely through them three-quarters of an inch and appear on the internal surface by narrow slit-like openings. These openings are about an inch and a half from each other, and the same distance behind the prostate. This tube is about the size of a goose-quill, but is very distensible.

Exploration of the ureter by a catheter passed into the bladder may be effected in the female. Select a No. 4 catheter and slip it over a sound slightly bent at the last half inch of its extremity; the patient is placed on the back with the legs and thighs flexed; pass the finger along the anterior wall of the vagina until it rests on the apex of the trigonum; now raise the end of the finger slightly when the orifice of the ureter will rest on its inner side; the catheter passed by the urethra must have its point directed to the inner side of the finger and with care its extremity will enter the constricted canal of the ureter; its position will be recognized by the course it takes; it may be passed readily as high as the crossing of the common iliac artery.

Wound of the ureter has occurred from shot and stab, and during operations. Shot and stab wounds are extremely rare; they occur in the back, and involve the ureter at its origin from the kidney. The symptoms are those of wounded viscera, with the escape of urine from the wound and hæmaturia. The treatment is rest and drainage of the wound.

Nephrectomy has been performed for urinary fistula following a wound of the ureter.[1]

The ureter has been wounded in removal of the uterus and abdominal tumors. The treatment recommended is to suture the renal end to the external wound. In an instance of division of the ureter while removing the uterus the renal end was turned into the vagina and retained by suture.[2]

Occlusion of the ureter may occur from the impaction of a stone. The symptoms are those of nephritic colic which continue with varying severity until the passage is made free. If the stone is near the upper end of the tube it may be reached by the operation of nephrolithotomy; if at the vesical extremity it may be removed by the rectum in the male and by the vagina in the female.

In a case[3] of nephrolithotomy on the left kidney this operation was followed by total suppression of urine, which was believed to be due to suppuration of the right kidney. A lumbar incision was made on the right side, the patient being placed on his belly with slight inclination towards the side of the operation; all the connective tissue under the quadratus lumborum was infiltrated with watery fluid resembling urinary infiltration; the fat was removed and an abscess discovered near the insertion of the pelvis; on opening it the finger was passed without resistance into the pelvis, which was so much dilated that the finger could be passed into the first part of the ureter; then with a slender, long, thin-bladed forceps a body was felt; by means of a large syringe warm water was injected which brought out a plug; a middle-sized bougie was now passed directly down into the bladder without resistance; a drainage-tube was left in the pelvis of the kidney for a week, but the urine passed by the normal course, and the patient rapidly improved.

---

[1] G. Simon. [2] H. Morris. [3] F. Lange.

CHAPTER LII.

THE URINARY BLADDER.

During infancy the bladder is pyriform and lies chiefly in the abdomen, but in the adult it is situated in the pelvic cavity behind the pubes; in the male it is in front of the rectum, and in the female the uterus and vagina are interposed between it and the rectum.

When quite empty the bladder lies deeply in the pelvis, when moderately full it is still in the pelvic cavity and has a rounded form, and when completely distended it rises above the brim of the pelvis and becomes egg-shaped; the base is directed towards the rectum in the male, and the vagina in the female, and the smaller end or summit rests against the lower part of the anterior wall of the abdomen; the anterior surface is entirely destitute of peritoneum, while the posterior is covered by the peritoneum, which is prolonged upon the base; the distended bladder has its long axis inclined upwards and forwards in a line from the coccyx to a point between the umbilicus and pubes.[1]

I. EXPLORATION.

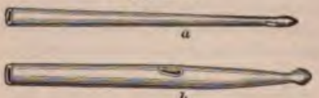
The cavity of the bladder may be explored to determine (1) its fluid contents, with catheters; (2) its solid contents, with sounds; (3) the changes in its mucous lining, with the endoscope.

If the urethra is very sensitive the injection of cocaine-solution will relieve all irritability.

The catheter is a tube composed either of metal, or soft material; the former is inelastic, while the latter is flexible. In practice, the metallic catheter is now seldom employed to draw off urine, for with the improved gum catheter this is done more safely, speedily, and conveniently.[2]

The gum-elastic catheter is made of every needful size, and may have a rounded, *a*, or an olivary extremity, *b* (Fig. 681). Its great advantage over the metallic instrument is, that ordinarily there is no great skill required in using it, and no danger is to be apprehended of lacerating the mucous membrane.[2] The soft rubber catheter is a perfectly harmless instrument, even in the hands of patients, and is adapted to cases in which the urethra has an irregular course.

Fig. 681.



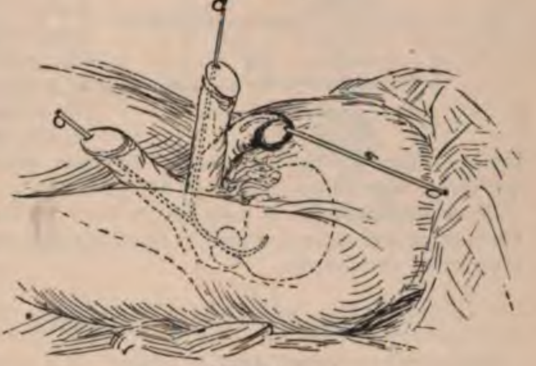
Gum elastic catheters.

In selecting a metallic instrument, the following facts should be borne in mind:[3] the instrument should be made of silver, and curved so as to be exactly adapted to the natural curve of the urethra in its least movable portion, which may be supposed to have its axis in the centre of the symphysis pubis;[3] this curve is equal to a portion of a circumferential line, equal to about three-tenths of a circle three inches and a quarter[1] in diameter. It is also important that the direction of the axis of the point should be at right angles to that of the shaft, whatever may be the length of the curve;[2] the operator can then always determine exactly the position of the point, however deeply the instrument may have penetrated. The handle of the instrument should have a ring on each side, near the external extremity, which are useful as guides to the position of the instruments, as aids in detecting obstructions, and as means of securing the instrument in the bladder. The eye should not be so large as to catch the mucous membrane. The gum catheter takes many forms adapted to special conditions; it may be made self-retaining by enlargements, or projections on its internal extremity.

---

[1] Quain's Anatomy. [2] J. W. S. Gouley. [3] Sir H. Thompson.

Fig. 682.



Catheterism.

The introduction of the catheter, although apparently very simple, is one of the nicest and most delicate processes in surgery.[3] Proceed as follows (Fig. 682): Place the patient in the recumbent position, with the head and shoulders slightly elevated by pillows, the knees a little raised and separated from each other to relax the muscles of the abdomen and perineum; standing or sitting on the left side of the couch, with the left hand support the penis, grasped by the thumb on one side and the fore and middle fingers on the other, or with palm upwards raise the penis between the ring and middle fingers applied just behind the corona glandis; with the thumb and the fore and middle fingers of the right seize the catheter, warmed and well smeared with oil or vaseline, and insert the point into the urethra; the instrument at this moment is nearly horizontal, the concavity of the curve looking towards the left groin of the patient; the instrument should be slowly carried onwards until four or five inches have disappeared, the fingers of the left hand gently drawing the penis over the instrument as it glides easily to the bulbous part; the handle should meantime gradually approach the median line, but still be maintained in the horizontal position; if there is any obstruction in a healthy urethra it occurs at the triangular ligament, where the end of the instrument passes along the floor of the bulb; withdraw the catheter half an inch; raise the shaft to the perpendicular, carry it steadily over, as the catheter passes along the fixed curve, and depress the handle between the thighs, as the extremity enters the bladder; a slight rigor, an expression of distress, the freedom of the point, and the flow of urine prove that the catheter has reached its destination. In removing the catheter give to the handle the same curve reversed.

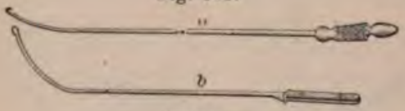
---

[1] Briggs. [2] J. W. S. Gouley. [3] S. D. Gross.

It sometimes happens that the part is extremely sensitive, and resists any but gentle efforts to traverse it, the more so if it be the first time an instrument has been introduced; the involuntary fibres close upon it as if to repel the intrusion, and the perineal muscles are prone to contract on the approach of the unwonted stimulus; some persons always exhibit this involuntary resistance, even when they have become in a measure habituated to the use of a catheter; in such cases no violence is to be used, as any attempt to force a passage would only increase the difficulty; gentle pressure steadily maintained, without any poking or jerking of the point, or relaxing of the hand at one moment and increasing its power at another, will sooner or later carry the instrument through.[1]

A solution of cocaine, four per cent., injected fifteen minutes preceding the operation, will relieve all sensitiveness.

Fig. 683.



Sounds.

The sound, *a*, *b* (Fig. 683), for exploring should be of solid metal, in order to give a clear note when it strikes the foreign body. Its curved part or beak should be little more than an inch long, and have more of a tendency to form an angle with the shaft than exists in the catheter; it may be hollow, and thus enable the operator to inject water into the bladder, or withdraw it without change of instruments.[1]

The endoscope is now rarely used in the examination of the bladder of the male; it has a limited value in examination of the bladder of the female.

II. MALFORMATION.

Extroversion of the bladder[2] is a congenital malformation, occurring chiefly in males, in which the anterior portion and the parietes of the abdomen are absent, so that the posterior and lower part of the bladder protrudes under the pressure of the viscera from behind as a round, red tumor, covered by mucous membrane, in which the orifice of the ureters can be seen.

The linea alba bifurcates at the upper angle, but is continued on either side of the ossa pubis, forming a triangle; the pubic bones are not united by a symphysis; the penis is small, the ureter and corpus spongiosum are deficient in their whole extent, and the only remnant of the urethra is a groove lined by mucous membrane on the dorsum of the penis; the glans penis is full and large, and the prepuce is usually of full size, but cleft above. In the female there is no urethra nor clitoris, but the mucous surface of the bladder is continued directly down into the vagina.

This deformity leads to painful and distressing results, owing to the constant flow of urine over the groin and thighs, but it is in no respect dangerous to life. The treatment may be palliative, by the application of an apparatus to collect the urine, of which there are many kinds. But even the best fitting does not always obviate the gradual soaking by the urine of the skin of the abdomen, groins, and perineum; and hence operations have been devised to relieve the disgusting deformity. Efforts have been made (1) to open communication between the ureters and the rectum,[1] but the operation is very dangerous, and has not given satisfactory results;[2] (2) to cover the exposed surface; some of these operations have been very successful, and have become legitimate by the approval of good authority.

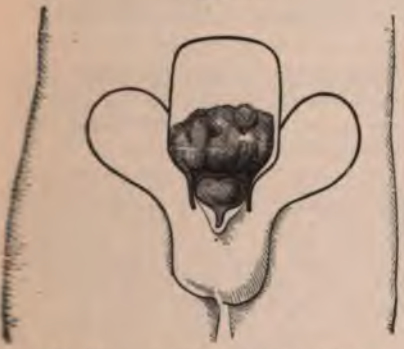
---

[1] Sir H. Thompson.

[2] T. Holmes.

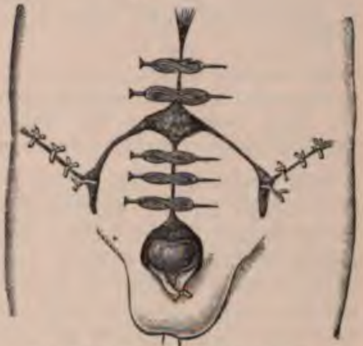
The most successful operations are as follows: Make an umbilical flap, 1 (Fig. 684),[3] and turn it down over the bladder; then make two flaps from the groin, one on either side (Fig. 684), and slide them over the central flap, and attach them in the median line (Fig. 685);[4] the result is, the skin surface of the middle flap presents to the bladder, and the raw surface is covered by the raw surfaces of the lateral flaps; the new wound is left to cicatrize. Or, dissect off the mucous membrane of the exposed bladder; make lateral flaps

Fig. 684.



Wood's operation for extroverted bladder. Outline of incisions.

Fig. 685.



Wood's operation; flaps applied.

Fig. 686.

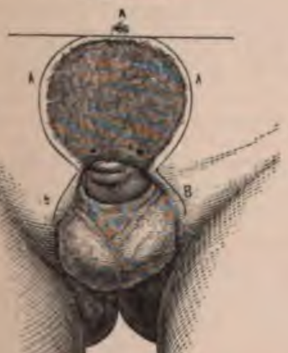
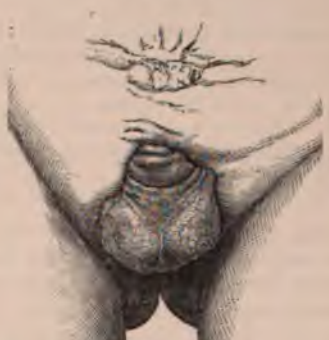


Fig. 687.



Bigelow's operation.

---

[1] J. Simon.

[2] F. Jourdan.

[3] Richards; D. Ayres; J. Wood.

[4] J. Wood.

from both inguinal regions (Figs. 686, 687); unite them upon the median line and transversely above it; the points A, A, A, and B, B, being brought together, as the skin more readily yields in a direction obliquely upwards; the result is perfect (Fig. 687).[1]

III. INJURIES.

Rupture of the bladder may be caused by (1) external violence, as direct blows, or falls, or crushing injuries; (2) muscular efforts, as in straining to pass water through an obstructed urethra, or during parturition; (3) thinning or ulceration of the walls of the viscus.

The rupture usually occurs when the organ is more or less distended, and the rent may be in the posterior walls covered with peritoneum, the contents of the organ escaping into the peritoneal cavity, or in the anterior walls, the extravasation taking place into the connective tissue.

The symptoms depend upon the direction which the urine takes; if it escape into the peritoneal cavity there is generally sudden pain in the lower abdomen and a desire to void urine; this effort usually aggravates the pain without accomplishing the purpose, though sometimes a small amount of water tinged with blood has been passed, and even with considerable force. Shock follows, which may prove fatal, but usually passes off, and reaction comes on with high fever, increased pain in the abdomen, and tympanitis; the desire to urinate diminishes, uræmic poisoning supervenes, and the case proves fatal within a few hours to four or five days.

If the extravasation is into the connective tissue, the immediate symptoms may be very slight, and it is not until the urine has penetrated to some extent, and its corrosive effects are felt, that they are well marked. A diffused swelling appears about the perineum and above the pubes; a low form of fever sets in, with typhoid symptoms; pain is not much complained of; the swelling extends in the subcutaneous tissues with a dusky redness, the surface is œdematous, the typhoid symptoms increase, and the patient dies, poisoned by the septic matters. The diagnosis is aided by the introduction of the catheter; if the rent is into the peritoneal cavity, the catheter passes readily into the bladder, withdraws a small quantity of bloody urine, and sometimes can be carried through the opening into the abdominal cavity; if the rent is in the anterior wall, a larger quantity of urine will be found in the bladder; if the urethra is torn, the catheter will be arrested before it reaches the bladder.

The treatment of rupture into the peritoneal cavity should be, in its early stage, by cystotomy, for the purpose of affording a direct outlet for the urine as it enters the base of the bladder. The method of opening the bladder should be that of lateral lithotomy, and the external wound should be maintained entirely free until the internal rent is closed. Recovery has followed the timely performance of this operation.[2]

It is undoubtedly of immense importance to remove the urine from the peritoneal cavity and cleanse and disinfect it, and an unsuccessful attempt has been made to effect this object by incision through the abdominal walls, closing the rent in the bladder by suture, and cleansing the cavity.[1] It would seem more rational to perform cystotomy first, to secure free escape of the secreted fluid, and then cleanse the cavity by incision made antiseptically; or to cleanse it by repeated injections of carbolized fluids and aspiration of the fluids injected through the same canula.[2]

---

[1] H. J. Bigelow.

[2] Walker; E. Mason.

If the extravasation is through the anterior wall, the swelling will first appear above the pubes, the fluid being forced in that direction by the deep fascia. Incisions should be made in the middle line of the perineum through the deep fascia, and the finger, introduced to the bottom of the wound, should gently force a passage towards the suspected point of rupture, for the purpose of opening a new and direct route for the escape of the urine; incisions should also be made into the external swelling caused by the infiltration of urine. If the water readily drains away by catheter, this instrument should be retained in the bladder.

Wounds of the bladder, by puncture or incision, are very rare,[3] but shot wounds are not infrequent in military practice. Though dangerous, the latter wounds are by no means fatal.[4] The chief points which demand attention in the treatment, especially of shot wounds, are (1) to prevent urinary extravasation into the neighboring parts; (2) to subdue inflammation; (3) to remove foreign bodies, especially those which may chance to lodge in the cavity of the organ.[4] If the wound is on the surface, uncovered by the peritoneum, the outflow may generally be effected by rest in the best position for drainage through the external wounds and through the catheter retained in the bladder, the catheter being of soft rubber and self-retaining; if these means do not succeed, the bladder must be opened at its most depending part by lateral lithotomy; if the wound is through the peritoneal surface, cystotomy is immediately necessary. The resulting inflammation is best controlled by rest, and opiates in doses which secure perfect quiet. Foreign bodies, as cloth and balls, may often be removed through the urethra; if bodies are of large size, or angular, the bladder should be opened by median lithotomy.

IV. INFLAMMATION.

The painful and tedious inflammations of the bladder have their basis in a peculiar hyperæmia of the mucous membrane. At first they are excited by local irritants, or obstructions to the outflow of the urine, but subsequently they are greatly aggravated by the action of the muscles. This is due to that peculiar arrangement of the arteries and veins of the lining membrane, by which the contraction of the muscles does not affect the afflux of blood through the arteries, owing to their strong connective-tissue sheaths, while it greatly retards the afflux of blood through the veins which are not thus protected, and hence are unduly compressed. As a result, the mucous membrane becomes so loaded with blood as to assume a dark purple color, thickened and velvety, in some cases coated with adherent lymph and phosphatic deposits from the urine, in others, ulcerated.

---

[1] A. Willet.

[2] J. W. S. Gouley.

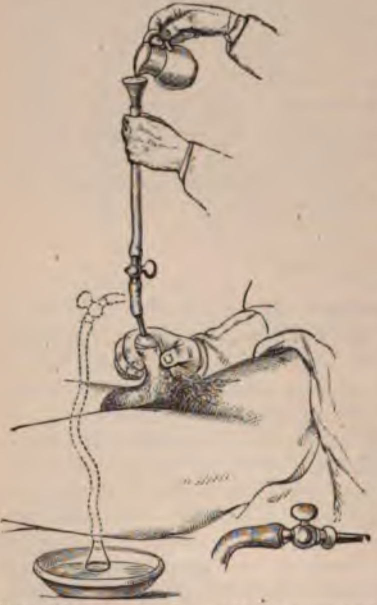
[3] G. A. Otis.

[4] J. A. Lidell.

Acute cystitis is very rare, and usually occurs when a urethral inflammation extends to its neck, or some injury is inflicted, or an irritant enters the bladder, as a rough foreign body, or a chemical substance. It always commences on the mucous surface; the irritation produces frequent and spasmodic muscular action, which leads to muscular hypertrophy, a constant phenomenon of cystitis. The symptoms are fever, great pain in passing water, frequency of micturition, bloody urine soon becoming purulent, pain and tenderness on pressure in the region of the bladder, and pain extending down the thighs and perineum. The treatment consists (1) in the removal of the exciting cause, if that can be determined, and of every possible source of irritation; for this purpose the patient should be kept quiet in bed, and drink freely of demulcent fluids, with alkalies, as soda or potash, which tend to dilute the urine and render it unirritating, if very acid; (2) the local hyperæmia must be relieved by leeches to the perineum, and, in very severe cases, hot hip-baths and warm fomentations; (3) the muscular spasm must be controlled by anodynes; opium by the rectum, as enemata or suppositories, is invaluable; or hyoscyamus, in large doses, may sometimes be preferable; or morphia injections into the bladder.

Chronic cystitis[1] never occurs as an idiopathic affection, but invariably arises from other morbid conditions of the urinary passages, as prostatic and urethral diseases, stone, morbid growths in the bladder or rectum, decomposing urine retained from any cause. The symptoms are those of acute cystitis, modified by the grade of inflammation, but the urine always contains pus. If the cause is removed and the symptoms continue, the treatment must be palliative, namely, suitable hygyenic conditions, and the injection of anodyne and disinfectant solutions, as morphia, with carbolic acid. One of the most important features in this treatment is irrigation of the inflamed surface with weak carbolic or boracic acid solutions;[2] this may be done by means of the catheter and syringe, the best being the rubber bag, with a tapering nozzle and stopcock; or the fountain syringe, with the necessary appatus, may be used.

Fig. 688.



Mode of washing out the bladder (the irrigator can).

A simple apparatus may be devised consisting of a piece of India-rubber tubing, two or three feet long, fitted to the catheter after its introduction; the fluid is poured into a funnel at the other end; the tube is raised to increase pressure, and depressed to empty the contents of the bladder (Fig. 688).

---

[1] Van Buren and Keyes.

[2] Sir S. Wells.

In obstinate cases, which resist all treatment, cystotomy has been performed with marked relief to the suffering.[1]

V. RETENTION OF URINE.

Inability to discharge the water accumulating in the bladder results in gradual distension of the organ; the cause may be stricture of the urethra, enlargement of the prostate, or paralysis of the muscular coats. The viscus distended appears above the pubes as an oval body, distinctly defined to the touch, and gives a flat percussion note; the finger in the rectum detects a globular tumor pressing into the lower pelvis, which often has a sense of fluctuation when percussion is made externally. If the cause is paralysis, a catheter must be frequently passed, and the bladder should be washed out with slightly carbolized water. If obstruction exists which cannot be relieved, the bladder must be punctured. The aspirator now affords the best means of withdrawing the fluid. The common bulb syringe may be attached to the large aspirating needle and the evacuation readily effected. Enter the needle just above the pubes, first making a slight cut through the integuments; the operation may be repeated at this point many times without danger, provided the bladder is so much dilated as to rise well above the pubes. Puncture with a small trocar and canula may be made at the same point.

Puncture by the rectum is sometimes resorted to, as follows: Select a small, long, curved trocar with silver canula; after the action of an enema, place the patient on the back with the thighs flexed; introduce the forefinger of the left hand into the rectum, until the tip rests upon the posterior part of the prostate; carry the point of the trocar behind the finger, and when it reaches the bladder thrust its point forward in the direction of the centre of the pubic cavity; withdraw the trocar, and when the urine has all escaped insert a cork in the canula and retain the latter by a bandage; if the bladder cannot be distinguished, puncture should not be made.

VI. TUMORS OF THE BLADDER.

Various forms of tumors may be found in the bladder, as cheesy tubercles, fibrous growths, cysts, villous formations, cancerous tumors. Diagnosis and removal of these formations has hitherto been very difficult, but by recently devised methods of procedure examination of the interior of the bladder by the finger has become practicable, and the removal of growths may be effected.

Exploration of the interior of the bladder with the finger is accomplished by opening the bladder through perineal incision of the prostatic portion of the urethra, as follows:—[2]

The patient having been secured in the usual position for lithotomy, and rendered insensible, a rather short median-grooved staff is carried into the bladder and held by an assistant. The knife to be employed should be straight, the blade very narrow, and about two and three-fourths inches long.

---

[1] W. Parker.

[2] Sir H. Thompson.

Make a vertical incision of the skin in the line of the raphé, an inch and a quarter long, terminating below about a half or three-quarters of an inch above the anus. Place the left index finger, palmar surface upwards, in the rectum, so as to learn the upper limit of the bowel, and introduce the knife with its cutting edge upwards, horizontally, into the wound until it reaches the groove of the staff, which should thus be struck about the junction of the membranous with the bulbous portion of the urethra; when contact is verified, lengthen the puncture of the canal a little with the point of the knife, which is then withdrawn, incising in the act perhaps some of the tissues, so as to enlarge the wound towards the external orifice, but avoiding as far as possible injury to the bulb. A director, resembling a small median gorget with blunt edges, passed into the groove of the staff, serves as a guide to the left index finger which is insinuated into the prostatic urethra, and gently pressed onwards until the tip, slowly dilating it, enters the neck of the bladder; arrived at this point, stand up, demand the full effect at this moment of the anæsthetic agent, and with the right hand press very firmly above and behind the pubic symphysis; by concerted movements between the left index finger and the right hand, now bring seriatim every part of the interior of the bladder over the point of the index, and scrutinize the lining membrane so as to learn its physical condition to the minutest particular. If there is the smallest growth, recess, or inequality of any kind, or even roughness, an adhering scale, or small calculus, it is recognized with ease and certainty. Occasionally when the subject is very fat, and the prostate large, considerable pressure is necessary to make the exploration complete, and now and then it may be impossible to reach the whole interior. But if the relaxation of the abdominal walls is absolute, it is surprising how far the contents of the pelvis, with the aid of an assistant, may be, by continued forcible pressure, brought down towards the perineum, and thus within reach of the operator's finger.

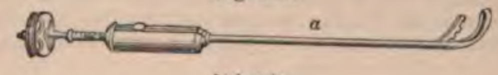
If in the examination of the bladder a growth is encountered, devote two or three minutes to deliberately estimating its exact size, form, and density; its position in the bladder, and whether others are present also; do this again after being reseated, with and without supra-pubic pressure by the assistant, so as to be thoroughly acquainted with the situation of the growth; then, withdrawing the finger, introduce slowly a pair of forceps, straight or curved according to judgment, to the spot, holding lightly a handle in each hand, when the growth will almost certainly be seized if movements be careful and deliberate; much in the same way as in seeking a nasal polypus. Being assured a fair hold, do not drag or tear out the body, or even much twist the forceps, especially if material is dense, for you may injure the bladder itself; it is better to jamb or mash together the rough margins of the forceps, before endeavoring to withdraw and effect separation thus: if this is not easily accomplished, introduce the left index and complete the separation with the finger-nail if possible, which is sometimes a very efficient instrument; proceeding thus, partly by suitable forceps, of which there are numerous forms, partly with the finger, the removal of the mass may be safely accomplished, entirely so if the growth or growths be simple and pedunculated ;, less completely when the base is wider, employing the forceps several times, carefully removing as much as possible piece by piece; and but very imperfectly if the tumor is mammillated and not at all pyriform in character. One source of danger must be carefully guarded against, viz., it may happen during the operation that the assistant is required to press very firmly above the pubes, so as to bring the growth nearer to the operator; by doing so at this stage, it is quite possible that the upper part of the bladder may be inverted and pushed downwards in a fold, presenting itself toward the operator as an eminence, and be mistaken for a large polypus or growth, an error which might be fatal. The possibility of this occurrence should not be lost sight of, hence the admonition to examine the bladder not only with, but without the influence of pressure, so as to ascertain precisely what is to be removed before any attempt to do so is commenced. After the removal whatever the result may be, a stout India-rubber tube about five or six inches long, and the diameter of the little finger, is secured in the wound to wash out the débris and to serve as a channel from the bladder to some vessel placed for the purpose. Hemorrhage is usually free for a few hours and gradually subsides; if the tube causes irritation it may be removed soon, if not, it may remain a day or two.

It has happened that on opening the bladder the expulsive efforts have expelled the free extremity of the growth through the wound, then after a day or two the removal was effected with forceps. Such a course, when practicable, is more safe and more accurate than crushing off the growth with the lithotrite. When the tumor is of the papillomatous character, it is probable that in no inconsiderable proportion of cases its expulsion may be looked for. In the female bladder the free ends of papillomatous growths are often floated outwards to and beyond the external urinary meatus.

VII. FOREIGN BODIES.

Substances introduced into the bladder through the urethra may be of every variety of structure and consistency. Whatever may be their nature, they tend to form nuclei for the deposit of the urinary salts, and either by themselves, or by the concretions formed, become sources of severe irritation of the bladder. The symptoms are those of vesical irritation from stone, namely, pain, obstruction to the free passage of urine, and evidences of cystitis. The presence of a foreign body may be acknowledged by the patient, or discovered by exploration of the bladder. If the foreign body is discovered it must be removed, and in such manner as to create the least possible injury to parts. The most serviceable instrument for general use, as in the removal of a portion of catheter, pin, bead, slate-pencil, small stone, is the lithotrite (Fig. 689).

Fig. 689.



Lithotrite.

The transverse diameter[1] is that which varies least, whatever may be the state of distension of the bladder, being smallest when the bladder is distended and greatest when it is empty; these peculiarities have a remarkable influence on the direction which foreign bodies take, and we know *a priori* that they tend to assume a transverse position; on entering the bladder from the urethra they are situated in an antero-posterior median plane. But after micturition the antero-posterior and vertical diameters are effaced, and the body changes its position; its posterior extremity receives an impulse from the corresponding wall of the bladder which tends to approach the neck; this impulse moves the anterior extremity from the median line, where it was at first, toward the right or left, on account of the persistence of the transverse diameter; as the bladder contracts, the posterior extremity is pushed forward by the diminution of the antero-posterior, and downward by the diminution of the vertical diameter; thus the transverse diameter is the only one which the body can assume when the bladder is empty. It may therefore be laid down as a rule that *rigid* and *elongated* foreign bodies tend to assume a *transverse* position. But, if their dimensions exceed six or eight centimètres, they cannot rest in this position, but must lie obliquely.[2]

The lithotrite is made of two halves, one sliding within the other, and is of an ordinary catheter when closed; it is introduced into the bladder by the urethra; then, by means of a screw or rack and pinion worked on the outer extremity, the movable part is made to slide back within the bladder, now forming two jaws, by which the body is seized; by turning the screw or handle, the blade is propelled onward, and the substance is firmly held and compressed, if possible, so as to admit of being removed readily by the urethra.

---

[1] Henriet.

[2] Med. Record.

Introduce it, and seize the body with the jaws of the lithotrite, and in such manner as will present its long axis to the long axis of the urethra. The exact position of the foreign body having been determined, place the beak of the instrument in immediate contact with it; now open the jaws by turning the screw, and when sufficiently separated give the beak a slight lateral movement and turn the screw so as to close the jaws; if the object is seized, the position of the screw will indicate its size. If, on attempting its withdrawal, the body cannot be engaged in the urethra, the instrument must be loosened and the body seized again with a view to change its diameter. If all efforts at extraction fail, the bladder must be opened by median lithotomy, and the body removed.

The following suggestions may prove useful:[1] The contractions of the bladder commence by raising up the posterior face and floor; these parts seem to advance toward the neck, leaving two prolongations on each side, which subsequently approach the neck. The neck is the fixed point and all other parts contract towards it, and the diminution of the capacity of the bladder commences by shortening of the antero-posterior diameter, which is followed by shortening of the vertical diameter. The elevation of the floor of the bladder is a very essential point in enabling the surgeon to grasp a fragment; in cases of enlarged prostate great difficulty may be encountered until the bladder commences to contract, raising the base and thus bringing the body within reach of the instrument. In searching for a body in an empty bladder, it may be impossible to move the instrument save in a lateral direction, and if this cannot be done the operator may be sure that the bladder has not been entered. When, however, the bladder is distended, as by an injection, these conditions immediately change; the foreign body becomes movable, and its position is no longer regulated by physiological but by physical laws; distension of the bladder by injection, therefore, so far from favoring the search for and extraction of the body, really hinders these manœuvres.[2]

CHAPTER LIII.

URINARY CALCULUS.

VESICAL stones result from the accretion of the salts of the urine around a nucleus. The central body is either a crystalloid deposited, from solution in the presence of colloids, or a solid body, introduced from without, as a pin. These stones vary in composition according to the constituents of the urine in each case, but the more common are 1. Uric acid; 2. Oxalate of lime; 3. Mixed phosphates, lime, ammonium, magnesium. The symptoms are pain at the neck of the bladder along the urethra, and under the glans penis; increased frequency of desire to void urine, with spasmodic pain at the close of the act; blood in the urine at the close of urination or after severe exercise; sudden arrest of the stream of urine while in full flow, with strong spasmodic contractions at the neck of the bladder attended by severe pain.[1] But the diagnosis must finally rest upon the detection of the stone by the sound. A patient suspected of having a stone should be subjected to a course of treatment preparatory to sounding, such as rest, regulation of the bowels, the use of diluents, tonics, and nutritious diet; the first exploration should be made with soft bulbous bougies, to estimate the calibre of the urethra and its sensitiveness; the second examination should be made in not less than two days with a searcher of abrupt curve and short beak (Fig. 689).[2]

---

[1] Heuriet.

[2] Med. Record.

When the sound enters the bladder it must be moved to and fro, to the right and left, and then reversed; large stones usually lie close to the vesical neck, and are readily felt, but medium and small-sized calculi are more apt to be found in the posterior part of the bas-fond on either side of the median line; the contact of the instrument with a calculus will determine by the note whether it is hard, soft, or encysted.[3]

The various operations for the removal of stone from the bladder are arranged under two heads, namely, lithotrity, or litholapaxy, by which the stone is crushed in the bladder and removed through the natural passages without cutting; and lithotomy, by which the stone is removed through an artificial opening made into the urethra or bladder. The operation of crushing the stone to facilitate removal, and thus avoid a wound, has undergone a remarkable revival within a very short period. From the position of an operation rarely performed and only in special instances, it has become the favorite method of procedure in the great majority of cases. There are many evidences that it will at no distant period supersede all other operations for the removal of the urinary calculus, except in a few extraordinary cases. It is now preferred in all ordinary cases of stone in the adult male, and in all cases of vesical calculi in women.

The management[2] of vesical stones strikingly illustrates the truth previously emphasized, that good judgment is quite as important as operative skill; but to attain the best success the two should go hand in hand. There is no exclusively best method of dealing with these foreign bodies, and there is no particular method applicable to all cases even of a kind, for experience teaches that one patient will bear immediate surgical operation, be it lithotomy or lithotripsy, while another of the same age, and apparently in the same state, will be killed by precisely the same treatment; the judicious surgeon, therefore, will select from among the many known operative procedures the one which is indicated after due consideration and study of all the peculiarities of the individual case.

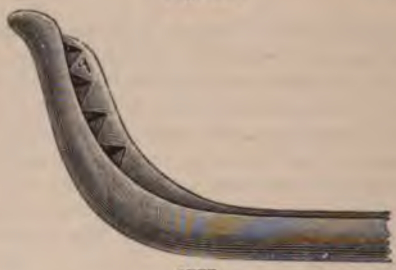
I. LITHOLAPAXY.

The operation of lithotrity has now been practically superseded by litholapaxy. The essential difference between the two operations is in the removal of the fragments; by the former the crushed materials are allowed to be expelled by the natural efforts of the bladder, but by the latter they are removed at once by a process of washing out the viscus. Two circumstances led to the practice of rapid lithotrity: 1. The irritation of the bladder by the fragments of stone after crushing, before they were expelled by the natural efforts, often intensely aggravated the previous inflammation due to the presence of the stone; 2. It had been demonstrated[1] that the capacity of the normal urethra was much greater than had hitherto been known. It was apparent, therefore, by crushing the stone more thoroughly, and introducing into the bladder a large tube, and applying suction force, the stone might be discharged at once, and the bladder would thus be entirely relieved of all sources of irritation. The results of the first efforts[2] to apply these principles to practice were eminently successful. The apparatus consisted of a more perfect lithotrite, and an evacuating instrument having a tube, 29 to 31 French scale, attached to a stout rubber bulb communicating with a glass receiver into which the fragments fell as they were drawn by suction into the bulb. The bulb is filled with water and attached to the catheter; then by alternate compression and relaxation water is forcibly thrown into the bladder, stirring up the fragments, and is then drawn by powerful aspiration into the bulb with the detritis of the stone which falls into the glass receiver, where it remains undisturbed as the operation proceeds.

---

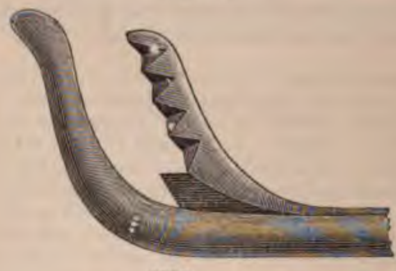
[1] Van Buren and Keyes. [2] J. W. S. Gouley. [3] Sir H. Thompson.

Fig. 690.



SHUT.

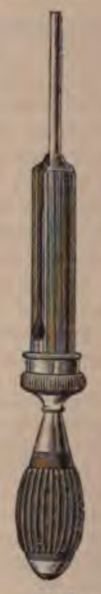
Fig. 691.



OPEN.

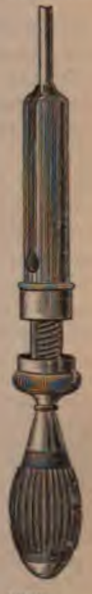
Jaws of Bigelow's lithrotrite, full size.

Fig. 692.



SHUT.

Fig. 693.



OPEN.

Handles of Bigelow's lithrotrite, reduced size.

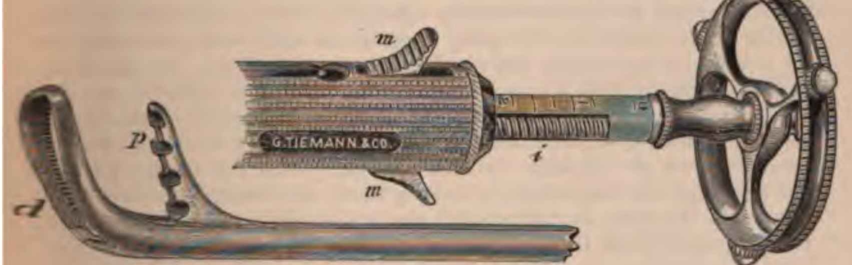
---

[1] F. N. Otis.

The lithotrite should be so constructed that it will not become impacted, will have adequate power, and will be of easy manipulation. These features are combined in an instrument (Fig. 691)[1] constructed as follows: The floor of the female blade is raised, and lateral notches added to the male blade, which is also provided with a central septum at the heel; the lateral grooves for the male blade extend through the heel of the female blade; the movement for locking the lithrotrite is by a quarter rotation of the bulb without displacing the fingers of either hand; as the rapidity of a lithrotrite depends upon the inclination of its screw thread, and as the slowest screw gives most power and requires the strongest blades, in the larger and more rapid operation larger and stronger blades than have been commonly employed, and which also better protect the bladder than do the latter, are desirable.

The blades of a lithrotrite[1] should be as nearly at right angles with the shaft, and their floor as straight, as is compatible with their convenient introduction into the bladder; many instruments are made with an oblique blade, which is also so rounded at the heel as to curve their floor; this is a mistake; a cubical stone, for instance, would exactly fit a right-angled lithrotrite; but when the same blades are made oblique, at an angle, for example, of forty-five degrees with the shaft, then, in order to grasp the same stone, they must not only be opened wider, but they will touch the stone at points nearer the shaft than before, for the size of their grasp rapidly diminishes with their obliquity; they must be opened wider, and they seize less of the stone; their power also diminishes, because, if they are made longer with the view of retaining the size of their grasp, their increasing leverage increases friction in the slide; this is readily seen by increasing their obliquity until they reach the line of the stem of the instrument, when they tend merely to roll the fragment between them; the latter then acts only as a wedge to separate them, and the friction of the slide is then greatest; in other words, right-angled blades crush best and wedge least; oblique blades, on the contrary, wedge more and crush less, while the depth of their grasp is also less; and what is here true of the whole blade is true of any part of it—the heel, for example, which should not be oblique nor much rounded, but as nearly at right angles with the shaft and with as straight a floor as is compatible with its convenient introduction. The tip of the female blade should be bevelled, so that if compared to a bent finger it may impinge against the upper wall of the prostate, while passing it, rather with its pulp

Fig. 694.



Keyes's fenestrated lithotrite.

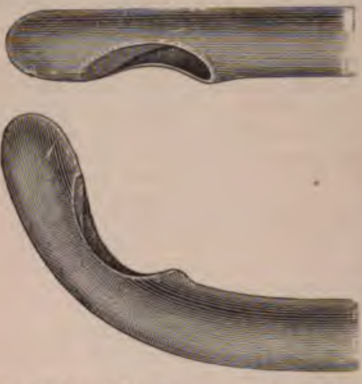
---

[1] H. J. Bigelow.

than with its nail. For the purpose of preventing the possibility of clogging the female blade may be fenestrated, so that the male blade, *p*, may be made to pass just beyond the female blade, *d*, if necessary[1] (Fig. 694).

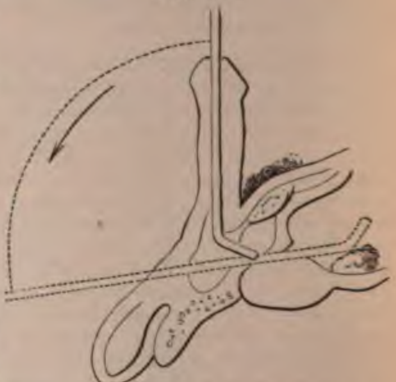
An efficient evacuating apparatus[2] consists of the following parts: (1) an elastic bulb; (2) a rubber tube two feet in length; (3, 4, 5) evacuating silver tubes of large calibre, straight or curved quite near the extremity; (6) glass receptacle. The calibre of the evacuating tube should be 28 to 31, or even 32 French scale, for upon its size depends its efficiency (Figs. 695 and 696). The apparatus has undergone important modifications The instrument now in use is as follows: 1. The evacuator[2] is an elastic rubber bulb with a glass receiver, and two stopcocks of metal (Fig. 697). The catheter is made to enter the bulb obliquely upwards, and is prolonged to the centre of the cavity by the tube, open at its end and perforated on its sides with numerous holes, which act as a strainer; the catheter, tube, and elastic bulb are in a straight line; this arrangement has the great advantage of not deflecting the current and thereby diminishing its force; during aspiration the current bearing the débris is drawn straight from the bladder through the tube, into the widest part of the bulb, and the fragments, spreading there, fall towards the receiver; but when the bulb is compressed the water returns mostly through the perforations in the side of the tube, because their area is collectively larger than the opening at the end of it, and because they are nearer the point at which the water passes out of the bulb; by means of this simple contrivance the water is strained, and the return of fragments is practically prevented; the tube strainer can be removed, cleaned, and replaced in a moment, and this is an advantage when there is much mucus, coagulum, or shreddy material in the urine, by which the holes of any strainer may be partly obstructed; even then this tube continues to work well, but it is better to pass a brush over

Fig. 695.



Bigelow's straight and curved catheter, full size.

Fig. 696.



Introduction of the lithotrite.

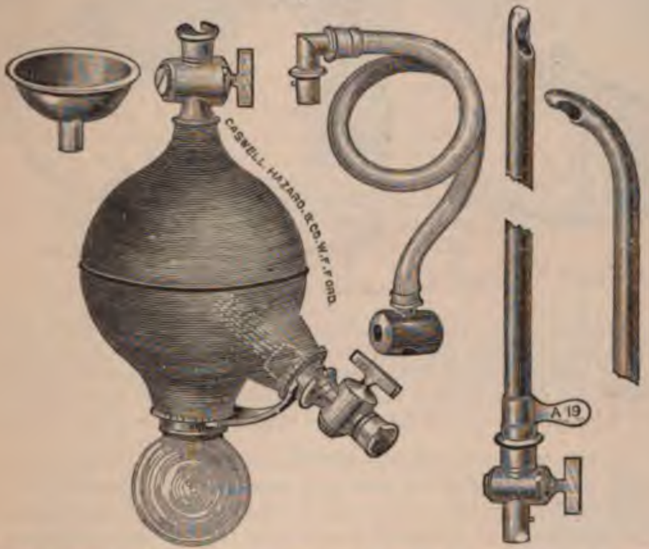
---

[1] E. L. Keyes.

[2] H. J. Bigelow.

it if mucus adheres to it; it can be examined as often as the receiver is emptied. After the water has once been changed less mucus will be found.

Fig. 697.



Bigelow's evacuator with an elastic bulb, glass receiver, and stopcocks; below there is a metal brace between the collar of the glass receiver and that of the catheter to steady the latter; within the bulb, and open at the end, is a tube strainer to prevent the return of débris: the bulb forms a concentric handle to the catheter.

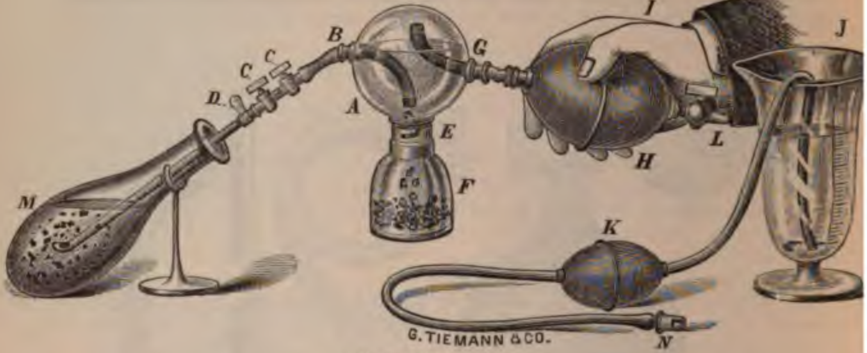
2. A very simple evacuator[1] has been devised, which, after several modifications, has now taken the present form (Fig. 698). Its peculiarities are readily recognized as represented in action.

It consists of a glass bulb, *A*, two inches in diameter, the reservoir, into one side of which a metal tube, *B*, forty mm. in circumference, curving down to its lowest part, is inserted; this is connected to the evacuating catheter in the bottle *M*; attached to the floor of the reservoir by a bayonet-joint, *E*, is a short, strong, glass bottle, *F*, the receiver; on the side of the bulb, opposite the tube connecting with the evacuating catheter, is another metal tube, *G*, curving upwards to near the top of the bulb *A*; this is connected by another flexible tube, with a strong India-rubber bulb, *I*, constituting an independent air-chamber: a stopcock at the extremity of the flexible tube permits the removal of the catheter without leakage from the reservoir *A*. The capacity of the reservoir *A* is just three fluidounces, that of the reservoir *F* one and one-half ounce. The instrument may be filled, preparatory to using, by means of an ordinary bulb syringe attached to the stopcock. The readiest and best way of filling the instrument is to plunge the evacuating end into a vessel of water, of a temperature of 98°, and by one or two firm compressions of the rubber bulb the filling is complete, and the evacuator is ready for use. If, during the operation, it is found desirable to introduce additional water into the bladder,

---

[1] F. N. Otis.

Fig. 698.



Evacuator in action.

this is done with great ease by attaching the discharge pipe of the bulb syringe to the stopcock *L*, while the supply end is immersed in a vessel, preferably a large glass graduate, filled with water of a proper temperature. The easy attachment and detachment of the bulb syringe at *L* allows any desired amount of fluid to be introduced into the bladder without delay or inconvenience.

Before the operation efforts should be made to allay any existing irritation of the bladder by rest and anodynes, continued for several days. The first in the operation is cleansing and disinfecting the bladder. Introduce[1] the curved tube selected for the operation, incising the meatus if necessary; through this tube drain away all the urine; now attach the washing bottle, charged with a saturated solution of borax at 100° F. to the tube; the urine having trickled away in its last drops through the tube leaves the latter full of air, which is fatal to nicety of washing; to dispose of this air withdraw the tube until its eye is in the prostatic sinus, then attach the washing bottle, and turn the stopcock when the air contained in the covered tube ascends into the top of the rubber evacuator as the tube becomes filled with water. Now compress the tube and force the water into the prostatic sinus and neck of the bladder, and at the same time pass the tube into the bladder; then by working the bulb by the hand the cavity is washed and disinfected. On withdrawing the tube leave two or three ounces in the bladder.

The next step is the crushing of the stone. Introduce the point of the beak into the urethra,[2] the instrument and penis being held as in catheterism, and carry it down to the triangular ligament; having reached this point, withdraw it slightly, and make traction on the penis to efface the depression of the floor of the urethra made by the end of the instrument; now, guided by the bony arch above, pass the point through the ligament; the rest of the canal corresponds with the axis of the body and is generally easily traversed, the instrument being pressed through the indurated neck, or prostate, in the direction of the axis of the body, with the hand on the perineum, when the prostate is large; if there is doubt, the tip may be guided by the finger in the rectum; the straight tube, or the shaft of a curved one, now returns to an angle of about 45° with the recumbent body. When in the bladder, the lithotrite should first be used as a sound, the blades being closed; pass the extremity from point to point, over the internal area, systematically exploring one region after another, in orderly succession, until the object is found, or the entire area of the bladder has been thoroughly examined.

---

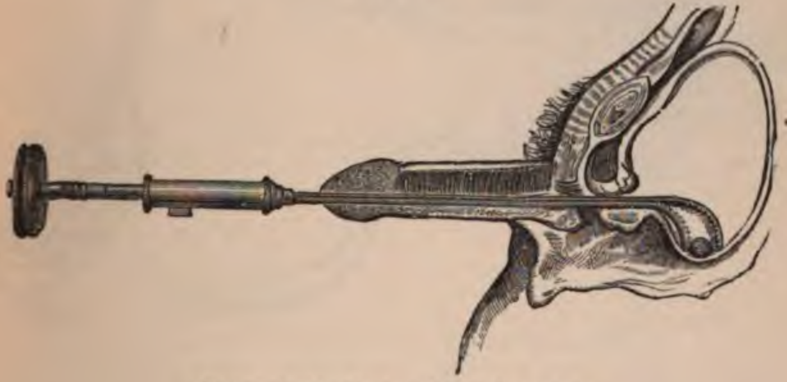
[1] E. L. Keyes.

[2] H. J. Bigelow.

In passing the lithotrite, the continuous sweep of the catheter will not be successful in carrying it into the bladder, as the terminal angular part constituted by the blades would thus impinge upon the anterior wall. It may happen that the meatus will not admit the instrument, when it must be incised in the direction of the frænum. In this exploration the instrument should not only be lightly thrust forward at every point, in order to strike with some force the object, but also turned rapidly with the fingers on its own axis from side to side, to enable the beak to detect anything situated laterally.

When the stone is felt, a slight lateral movement of the blades determines on which side it lies; incline the blades away from it and pass them towards the posterior wall, while the male blade is unlocked and withdrawn; then incline the blades towards the stone and slowly close them upon it (Fig. 699).[1] Or, the blades may be passed to the most depending part of the bladder, the base, and the male blade withdrawn with a view to enable the stone to fall between them; this object may be effected sometimes by a slight jar of the handle by tapping with the fingers.[2] The stone having been seized, the screw must be slowly turned until the grasp is firm, and such movements of the blade should be made as will prove that the instrument has not seized the mucous membrane. Grasping the handle firmly with the left hand, turn the screw with the right, until the stone breaks; withdraw the male blade, and, without moving the instrument, again close them upon such fragments as fall between them; this act must be

Fig. 699.



Method of seizing the stone behind the prostate.

---

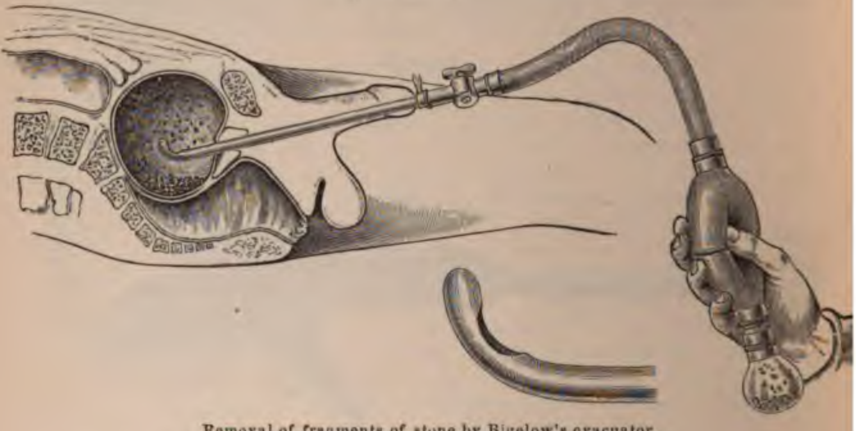
[1] M. Civiale.

[2] B. C. Brodie.

repeated until all the fragments are pulverized, when the instrument must be withdrawn.

The following practical maxims[1] in the performance of lithotrity are important in litholapaxy: (1) execute every movement deliberately; open and close, incline, or rotate, slowly, without any jerk whatever, and without bringing the blades, as far as possible, in contact with the walls of the bladder; (2) take care that the blades reach or pass beyond the centre of the bladder before the male blade is withdrawn; (3) maintain the long axis of the instrument in the median line of the body and the blades at or near the centre of the bladder, this being the area for operating mostly to be chosen; in screwing home the male blade to crush it is especially necessary to keep the instrument steady, for a small deviation of the handles produces a large one at the blades; (4) when the stone is caught, especially in the fenestrated lithotrite, rotate it a fourth of a turn on its axis before crushing to make certain that nothing is included besides the stone; (5) having broken the stone, the fragments fall immediately beneath the instrument, where they may be seized without searching, and crushed, if the instrument is carefully worked, exactly in the same spot, the patient not moving; (6) never withdraw the lithotrite loaded with calculous débris.

Fig. 700.



Removal of fragments of stone by Bigelow's evacuator.

The last stage of the operation is the application of the evacuator to the removal of the fragments. The tube is again inserted and the former precautions taken against the admission of air; the tube is first held so that its curve passes backwards and downwards upon the bladder behind the trigone; as the washing progresses the end of the tube is removed from side to side, and partly drawn out, finally inserted and held a little way up by depressing its distal end. If the tube is straight its apertures should be as nearly as possible in the centre of the bladder, and preferably turned downwards, and it should be rotated in different directions. The straight tube with an open end must be so held that its opening lies just inside the neck of the bladder (Fig. 700).[2]

[1] Sir H. Thompson.

[2] E. L. Keyes.

The washing is performed by an easy succession of synchronous movements of the hand; when fragments come into the receiver more slowly, compress the bulb rather violently, and hold it for an instant, then suddenly relax, with a view of catching a lost fragment; if a large fragment lodge in the tube, known by the sudden stoppage of fragments and their contact with the end of the tube, forcibly compress the bulb, and if this does not dislodge it detach the evacuator, and pass a stylet down the tube and push the fragment back into the bladder; as the tube is moved from side to side the bladder wall often flaps with a sharp click against the eye, and then flutters spasmodically with dull thuds against the open end of the instrument; this movement must not be mistaken for contact with fragments.[1]

After the fragments cease to collect in the receiver, remove the tube, and have the receiver emptied and refilled; meantime introduce again the lithotrite, seize and crush the fragments; reintroduce the tube; attach the evacuator, and again remove the fragments; repeat the crushings and washings until the fragments are all removed.[2] A last fragment is sought for by auscultation during the process of washing; every bubble of air is removed from the bladder and with a small tube it is gently washed while the operator places his ear directly over the lower part of the abdomen; any fragment of stone still remaining will sooner or later be driven against the metallic tube so as to be detected.[1] The after treatment is rest in bed, with appropriate remedies for special symptoms.

II. LITHOTOMY.

At present the following selection of cases for lithotomy is advised;[1] all others are suitable for litholapaxy: 1. Male children before puberty; 2, all cases complicated by severe chronic cystitis; 3, tumors of the bladder complicating stone; 4, some cases of prostatic overgrowth, not complicated with atony; 5, some cases of very large prostate through which instruments cannot readily be made to pass; 6, cases complicated by severe, deep, urethral stricture; 7, cases of very large or very hard stone; 8, cases of encysted stone; 9, cases of certain foreign bodies.

Lithotomy has been modified from time to time, but at present three methods are recognized as especially adapted to all the conditions under which the operation is required, viz: lateral, median, and suprapubic lithotomy. The patient should be prepared for the operation, and antiseptic solutions should be employed during the operation and at the dressings.

Lateral lithotomy is so named from the lateral incision of the prostate gland and neck of the bladder. This method is undoubtedly best in children, as the incision is not liable to injure the seminal ducts, a free outlet is afforded for the extraction of the stone, and there is little danger of peritonitis from violence, even with large stones; in the adult it is to be preferred when the bladder is contracted; and where the stone is small or large when the bladder is more than ordinarily irritable and inflamed. The special instruments required are a shirted canula (Fig. 701), a grooved staff (Fig. 702), a straight or beaked bistoury[3] (Fig. 703), or lithotome,[4] straight and

---

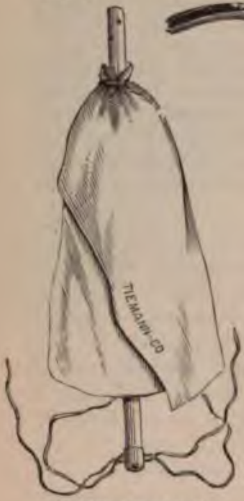
[1] E. L. Keyes.

[2] Van Buren and Keyes.

[3] W. Blizard.

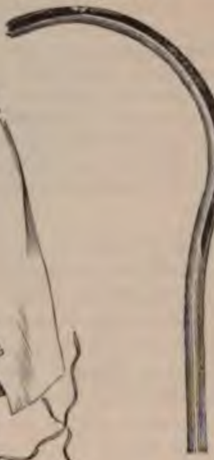
[4] Briggs.

Fig. 701.



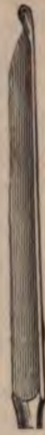
"Shirted canula."

Fig. 702.



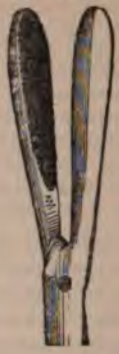
Grooved staff.

Fig. 703.



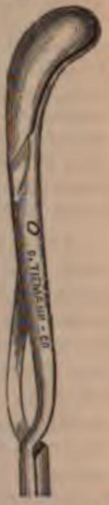
Beaked bistoury.

Fig. 704.



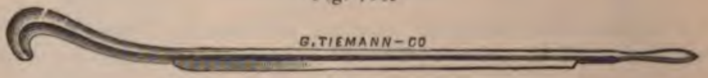
Straight forceps.

Fig. 705.



Curved forceps.

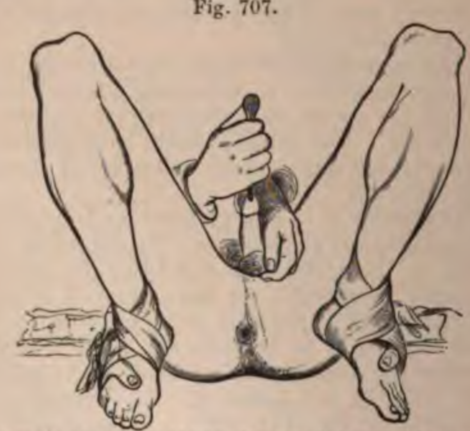
Fig. 706.



Scoop.

curved forceps (Figs. 704 and 705), the scoop (Fig. 706) for the removal of fragments and as a conductor for the forceps in deep wounds.

Fig. 707.



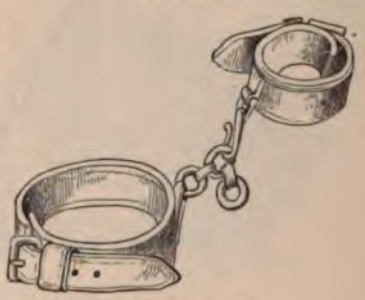
Position of patient and line of incision in lateral lithotomy.

Operate as follows:[1] Every care being taken that the patient is in favorable condition the perineum should be shaved and washed with bichloride solution, an enema of warm water administered about an hour before; after its action the urine should, if possible, be retained until the operation. Place the patient on the operating table and give the anæsthetic. Now flex the legs and thighs, and it is a good proceeding to place the hands alongside of the feet and bind the two together with firm bandages (Fig. 707) or lithotomy bracelets may be used (Fig. 708). Introduce the staff (Fig. 702), which should be as large as the urethra will admit with ease, and of such a shape as that delineated, having the groove presenting a little to the left side of the urethra; the instrument should, if possible, be made to strike the stone, and should then be given in charge of an assistant. The hips should be brought to the margin of the table, the staff held nearly perpendicular, with the concavity of the curve resting on the upper part of the triangular ligament right side; sit in front of the perineum, having previously arranged with an assistant about having the instruments handed, or having already assorted them properly in pans. Pass the forefinger of the left hand, well oiled, into the rectum, to ascertain the size of the prostate and the depth of this organ from the surface; trace the course of the ramus of the pubis and ischium on the left side, ascertain the position of the tuberosity of the latter bone on each side, and, having scanned the whole surface, proceed to use the knife, grasping it much in the manner of a common bistoury, but with the hand and instrument pointed directly to the perineum; enter the point about one inch and three-fourths in front of the anus, a line's breadth left of the raphé; push through the skin, and carry it by a kind of sawing motion down the left side of the perineum, beyond the anus (Fig. 707) and 2, 3 (Fig. 716), the middle of the incision being at equal distances from the latter part and the tuberosity (Fig. 709); cut along the surface of the exposed fat and cellular tissue, and then thrust the point of the forefinger of the left hand into the wound a little in front of the anus, so as to penetrate between the accelerator

---

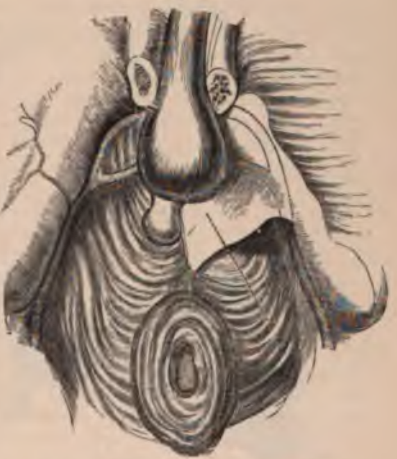
[1] Sir W. Fergusson.

Fig. 708.



Lithotomy bracelets.

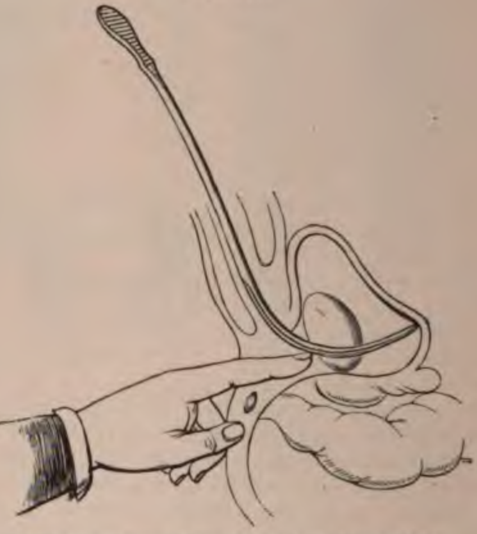
Fig. 709.



Arteries of perineum and deep fascia.

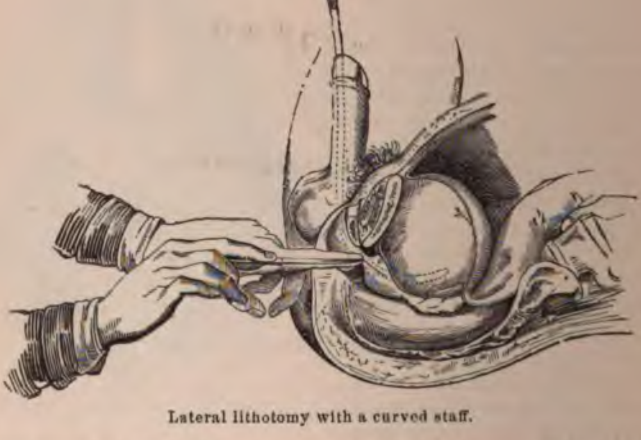
urinæ muscle and the erector, the knife being applied to any part which offers resistance; the finger can now be placed upon the membranous portion of the urethra, and the groove in the staff may be distinctly felt (Fig. 710); carry the point of the blade, with the flat surfaces nearly horizontal, on the side of the finger (Fig. 711), and perforate the urethra about three lines in front of the prostate,

Fig. 710.



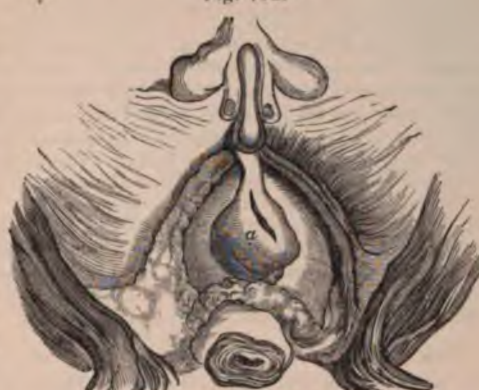
Lateral lithotomy; finger-nail in groove of the staff.

Fig. 711.



Lateral lithotomy with a curved staff.

Fig. 712.



Incision in prostate.

and carry it along the groove until it has entered the bladder, having slit open the side of the urethra and incised the prostate in its course, *a* (Fig. 712). Now slip the forefinger of the left hand slowly into the bladder along the staff, in such a manner as to cause dilatation of the surrounding textures, and move its point about in search of the stone, which, being found, should be retained in position near the neck of the viscus. Remove the staff, and introduce the forceps along the upper surface of the finger, slowly withdrawing the latter as the former makes progress; their entrance will be denoted by a gush of urine, at which instant the blades should be separated, when on gently approximating them the stone will, in all probability, be felt inclosed. If it is not, the process may be repeated, if the water still flows, but should the bladder now be empty, the closed blades should be quietly moved about the bladder until the stone is touched, and at this time, in opening and closing them, great care should be taken to avoid any injury to the bladder; extraction being effected, the operation is completed.

Unless the calculus be large and palpable, and well ascertained before, never cut into the bladder without feeling the concretion when the patient is on the operating table; in general, the staff suffices for all the sounding which may be required at this particular time.[1] Before commencing the incisions, determine that the point of the staff has not slipped out of the bladder, and place it in the attitude at which it is to be held afterwards, and then give it in charge to the assistant; the length of the external incision in the adult should be about three inches; but if the patient is fat, the perineum deep, and the stone large, it should be made longer, at both ends, but more especially in front.[1] A free division of the skin is a most important feature in the operation; but beyond this the application of the knife should be extremely limited; the point of the finger may, in general, be thrust without much force into the space between the accelerator urinæ and erector penis, provided the superficial fascia has been cut.[1] In a large majority of cases the opening in the deep part of the perineum and neck of the bladder need not at first be larger than what the forefinger will stop, and as the latter follows the course of the knife as soon as it is withdrawn, there will be as yet only a slight escape of urine; but when the forceps are used the fluid will gush out at once, at which time, as already stated, the stone may probably be seized, and thus farther dilatation or the reapplication of the knife may be decided according to circumstances; it is rarely necessary to apply the knife again, for dilatation or laceration is safer than free incision into the tunics of the bladder beyond the prostate.[1]

The principal hazards[1] during the operation are, wound of the rectum or of some large bloodvessel; the former will be best avoided by keeping the knife, when in the deep part of the wound, chiefly above the finger, which may also be used to depress the gut. Under the age of puberty there is seldom any annoyance from hemorrhage, but in the adult there may be both trouble and danger. The superficial perineal artery, or its transverse branch, is occasionally of such size, that, when divided, a ligature may be necessary; it is (Fig. 709) so near the margin of the wound that it can be secured with great facility. The artery of the bulb will seldom be cut, as the point of the knife should never be carried so high as this part. Perhaps the most troublesome hemorrhage may be from the veins around the neck of the bladder, which, in those advanced in years, are often of considerable size. If necessary, the opening in the skin might be enlarged, to permit the application of a ligature to a deep-seated artery, and it might even be possible to carry a curved needle round the pudic, were this deemed advisable; but in the generality of instances the bleeding ceases as soon as the patient's thighs are placed together, or the shirted canula (Fig. 701) may be introduced.

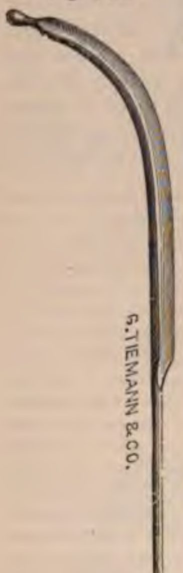
---

[1] Sir W. Fergusson.

The treatment after lithotomy, as regards diet, the state of the bowels, and the various evil consequences of the proceeding, not particularly referred to above—such as infiltration, wound of the rectum, inflammation of the neck of the bladder or of the peritoneum—should be conducted on the ordinary principles of surgery.

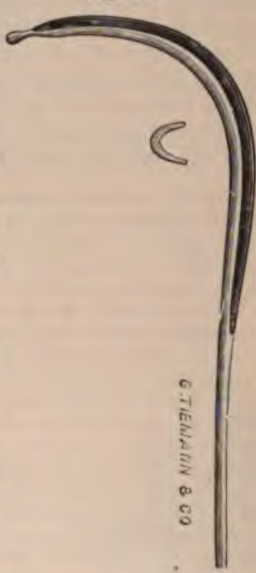
Median lithotomy[1] is eminently applicable for small stones in a bladder which will not tolerate the use of instruments without chill or other disturbance; for multiple small stones in the adult; and for boys too young for lithotrity.[2] The instruments required are a staff, director, and knife. The staff has a broad, deep groove (Fig. 713;[3] but there are advantages in having a larger curve and deeper groove (Fig. 714)[4] A director (Fig. 715) six inches long, with a flat, tapering groove and probe point, is very desirable to pass along the staff, after the knife is withdrawn, as a guide to the finger. The operation is as follows: The patient being properly placed and etherized, and the staff in the hand of an assistant, introduce the left index-finger into the rectum, and place its extremity in contact with the staff so as to steady it; with the knife, pierce the perineum in the middle line about half an inch above the anus, or at such distance as

Fig. 713.



Staff.

Fig. 714.



Grooved staff.

---

[1] G. Allarton.

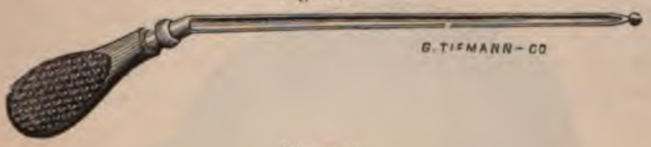
[2] Van Buren and Keyes.

[3] T. M. Markoe.

[4] J. L. Little.

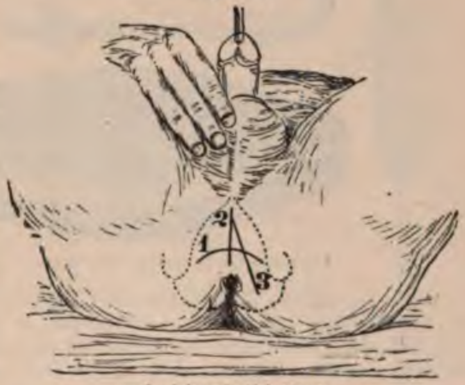
will clear the fibres of the external sphincters, 1 (Fig. 716); carry the knife steadily and firmly on till it strikes the groove of the staff; now move the point of the knife along the groove a few lines towards the bladder, and then withdraw it, cutting upwards,[1] so as to leave an external incision of from three-quarters of an inch to one inch and a half, according to the size of the stone; introduce the director (Fig. 715) along the groove well into the bladder, and remove the staff; pass the index-finger of the left hand, well oiled, along the director, with semi-rotary motion, through the prostate into the bladder; when the stone is free, it comes in contact at once with the finger, and passes into the wound on withdrawing the finger; the patient makes powerful expulsive efforts, which keep the stone in contact with the wound, where it may be seized with forceps; if the stone is larger than the finger, the opening must be dilated, or the stone may be seized with a lithotrite and crushed; or, if very large, the wound may be enlarged by vertical or lateral incisions.

Fig. 715.



Directors.

Fig. 716.



Incisions in lithotomy.

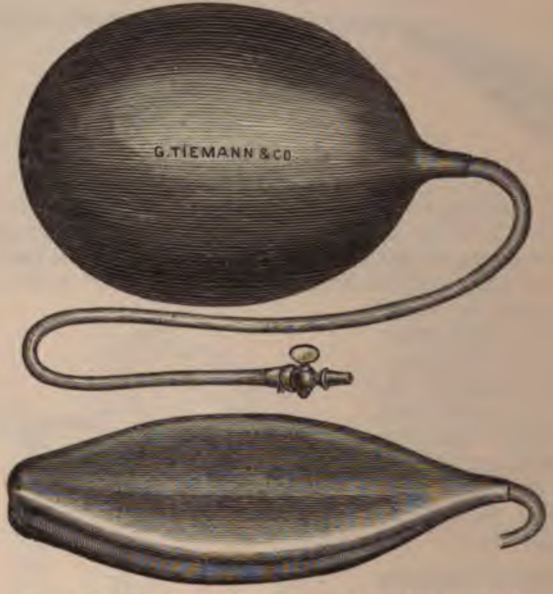
Medio-lateral lithotomy was devised on account of the dangers of lateral lithotomy; the membranous portion of the urethra is opened upon an angular staff, and the prostate is divided laterally. The following method is more easily executed, and is in other respects preferable: The patient placed in the ordinary position for lithotomy, the staff in position, an incision is made in the median line of the perineum, from before backwards, and terminating two or three lines in front of the anus; from this point the incision is continued for a quarter of a circle around the left side of the rectum; the rectum is pressed back with the finger of the left hand aided by the knife; the left index-finger is now passed into the rectum, and the knife, with its back towards the bowel, is passed at the posterior part of the central incision into the membranous portion of the urethra; the incision of the prostate is made from within outwards; in children, a single incision is sufficient, but in adults the circular part of the wound should be deepened before or after the urethra is opened; the forceps is now introduced, and the stone removed, 2 (Fig. 716).

---

[1] G. Allarton.

Supra-pubic lithotomy has recently been improved in its details, and is now regarded as the best method of removing very large stones from the bladder. The danger of wounding the peritoneum has been much diminished by the device of distending the rectum, which elevates the peritoneal folds from the pelvis and uncovers the anterior face of the bladder. The special apparatus is a rubber ball with a tube attached, rectal colpeurynter, for the distension of the rectum (Fig. 717).

Fig. 717.


G. TIEMANN & CO.

Apparatus for distending the rectum collapsed and distended.

When the bladder alone is filled the peritoneum is not raised from the pubis, or but slightly; but if there is distension of both the bladder and rectum,[1] the fold of the peritoneum in front of the bladder may be raised from the pubis so as to give a considerable clean space, thus greatly facilitating the safety of supra-pubic operation of lithotomy; thus thirteen ounces in the bladder and sixteen ounces in the rectum removed the peritoneum three and a quarter inches.[2]

The procedure is as follows: Cleanse and disinfect the surface of the abdomen; now inject slowly into the bladder with a piston-syringe warm water, six ounces to a pint, according to the tolerance of the bladder, care being taken not to over-distend the organ and retain by a tape around the penis; the next step is to introduce into the rectum the rubber ball, well oiled, and slowly distend it with warm water, the amount used varying from twelve to twenty ounces. Make an incision exactly in the median line three or four inches long from the symphysis pubis; separate the pyramidal muscles, raise the layer of fat over the bladder from below upward, puncture the bladder, at the point where the finger rests below the peritoneal fold, and incise the organ from one to one and three-quarter inches. With the finger follow the bistoury into the cavity and detect the stone, untie the tape around the penis, and with forceps seize and slowly remove it without bruising the parts. Two tubes, with fenestra at their inner extremities, are introduced on the finger to the bottom of the bladder, long enough to terminate in a vessel placed between the thighs, and retained by a stitch to the margins of the wound. The wound is closed by sutures passed without contact with the walls of the bladder, and iodoform dressings applied. The bladder may be washed out by injecting fluid through one of the tubes; the dressings are to be changed only when required; the tubes are removed at the end of a week, and the catheter used at such intervals as may be necessary. The wound usually unites at the end of twenty days.

---

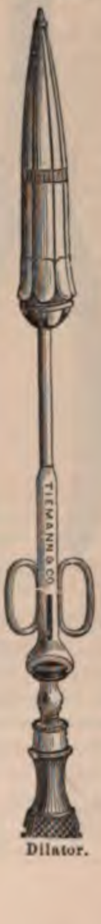
[1] F. Petersen.

[2] Fehleisen.

III. PERINEAL LITHOTRITY.[1]

This operation is rarely performed, and yet it is regarded as having a limited usefulness. It is based on the extreme dilatability of the vesical neck without injury, and is adapted to large calculi in an irritable bladder, conditions which may prove unfavorable to litholapaxy and lithotomy. It consists in opening the urethra by perineal incisions, dilatation of the neck of the bladder, crushing of the stone by forceps, and its immediate removal.

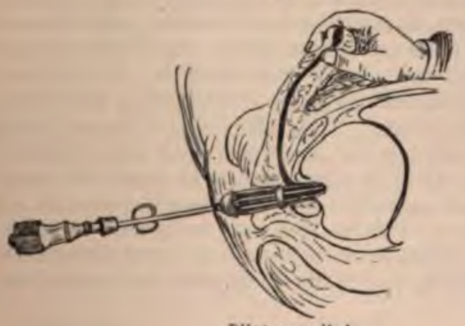
Fig. 718.



Dilator.

The special instruments required are a strong, straight, lancet-pointed bistoury, a six-branched prostatic dilator, three or four lithoclasts of different shapes and strength, two or three pairs of small straight and curved forceps, a scoop, and a long-nozzled rubber syringe. The dilator (Fig. 718) is composed of six uniform metallic branches held together by an India-rubber band; the vesical end is conical, and surmounted by a small metallic hood which covers the free extremities of the six branches, and fits in the groove of the staff; in the centre of the branches are two spheres attached to a stem which

Fig. 719.



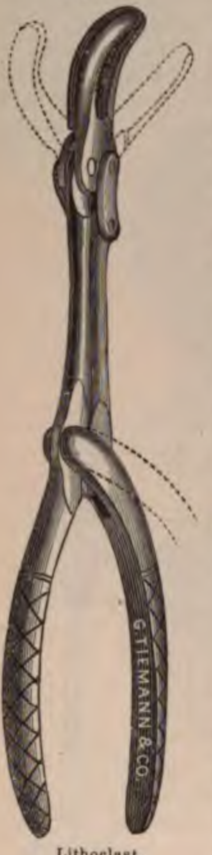
Dilator applied.

Dolbeau.

extends from the hood at the vesical extremity to terminate by a screw-thread in the handle; when the handle is turned the spheres are pushed forward from their concealed position, and the instrument is gradually developed.[1]

The operation is as follows:[1] The patient, properly prepared, is etherized and placed in the lithotomy position; the staff is held in position by an assistant; an incision a little less than an inch is made in the median line, extending to the anal margin, the skin, superficial and deep fascia, being divided; the left index-finger nail is pressed into the groove of the staff, and the membranous portion punctured with the knife, the bulb and rectum being avoided; the urethra is incised about one-fourth of an inch, and the extremity of the dilator introduced along the groove of the staff (Fig. 719), and methodical divulsion of the urethra begun; by this effort, the external wound and urethra are so enlarged that the closed instrument enters the prostatic portion, which is slowly dilated while the handle is depressed 130° to carry the point nearer the vesical neck; the dilator is again closed and advanced, the staff removed, and dilatation again slowly made; in this third step the introduction and opening of the dilator must be very slow, no violence being used, and when there is great resistance the process should stop for a moment, and then be slowly repeated, until the vesical neck admits the dilator; the instrument should be withdrawn open. The reduction of the stone, lithoclasty, is now practised. The lithoclast (Fig. 720) is a powerful forceps of small diameter when closed, and admitting of opening of the beaks without increasing the shaft, and in its improved form, with curved beaks, to admit of seizing stones behind the pubes.[1] The extraction of fragments is made with the lithoclast and scoop. The after-treatment is the same as for lithotrity.

Fig. 720.



Lithoclast.

IV. VESICAL CALCULUS IN WOMEN.

Vesical calculi in women may be removed by the following methods: 1. Extraction through the dilated urethra if the stone is of small size, thus: Give an anæsthetic, place the patient in the lithotomy position, and, with a dilator, consisting of two blades, or dressing forceps, introduced closed, distend the canal forcibly, until it is of the requisite calibre; seize the stone with strong forceps, and slowly withdraw it; in children, a stone of one inch, and, in adults, a stone of two inches in diameter may be removed by rapid dilatation.[2] 2. If the stone is larger, crush it with the lithotrite, and remove the fragments with the evacuator, as in litholapaxy. This method is now adapted to nearly all cases of calculi in women. If this operation is not advisable, resort to one of two other methods, viz: 1. The bladder may be opened through the vagina[3] by cutting from before backwards on a grooved director introduced through the urethra, and made to depress the vesico-vaginal septum; the wound must be immediately closed on the extraction of the stone, as in vesico-vaginal fistula. 2. The supra-pubic method may be practised, when the stone is very large, in the same manner as in the male.

---

[1] J. W. S. Gouley. [2] T. Bryant. [3] J. M. Sims.

CHAPTER LIV.

THE URETHRA.

THE urethra[1] is a tube of continuous mucous membrane, about eight and a half inches in length, supported by an outer layer of submucous tissue connecting it with the several parts through which it passes, and containing two layers of plain muscular fibres, the innermost being disposed longitudinally, and the outer circularly.

It is divided into three parts: (1) the prostatic, which passes through the upper part of the prostate gland, and is the widest part of the canal, being larger in the middle than at either end, and twelve to fifteen lines in length; though inclosed in firm glandular substance, it is more dilatable than any other part of the urethra; (2) the membranous portion which extends from the apex of the prostate to the bulb, being three-quarters of an inch along its anterior and half an inch along its posterior surface, owing to the projection upwards of the bulb; it is the narrowest division of the urethra; (3) the spongy portion, which includes the remainder of the canal, is about six inches in length, the bulbous portion being the largest; the succeeding portion of the canal is of uniform size to the glans, where it again expands, forming the fossa navicularis, which is from four to six lines in length, and terminates in the vertical fissure, meatus urinarius, two to three lines in extent.

I. EXPLORATION.

The urethra-meter[2] (Fig. 721) is designed to gain a definite knowledge of the calibre of the urethral canal in cases with or without contraction of the meatus.

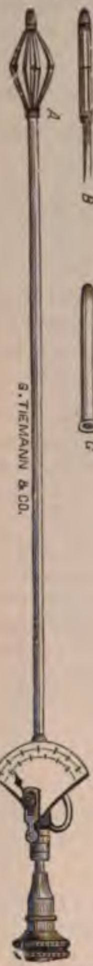
It consists of a small straight canula, size No 8 F., terminating in a series of short metallic arms, *B*, hinged upon the canula and upon each other; at the distal extremity, where they unite, a fine rod running through the canula is inserted; this rod is worked by a stationary screw at the handle of the instrument, and, when retracted, expands the arms into a bulb-like shape, *A*, ten millimetres in circumference when closed, and capable of expansion up to forty millimetres; a thin rubber stall, *C*, drawn over the end of the closed instrument, protects the urethra from injury, and prevents the access of the urethral secretions to the interior of the instrument. When introduced into the urethra and expanded up to a point which is recognized by the patient as filling it completely, and yet easily moving back and forth, the index at the handle then shows the normal circumference of the urethra under examination; in withdrawing the instrument, contractions at any point may be exactly measured, and any want of correspondence between the calibre of the canal and the external orifice be readily appreciated. Among the advantages claimed for the instrument are: (1) its capacity to measure the size of the urethra, and to ascer-

---

[1] Quain's Anatomy.

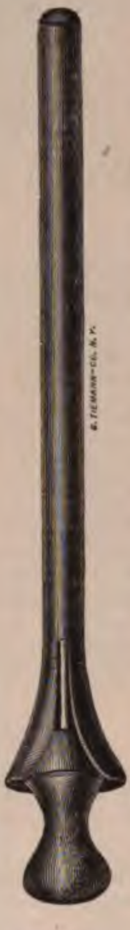
[2] F. N. Otis.

Fig. 721



Urethra-meter.

Fig. 722.



Endoscope.

tain the locality and capacity of any strictures, without reference to the size of the meatus; (2) it enables the surgeon to complete the examination of several strictures by a single introduction of the instrument, and by reduction of its size to avoid the irritation which usually attends the withdrawal of the ordinary bougie-à-boule or bulbous sound.

The endoscope is an instrument for the direct exploration of internal parts by the sight, as the interior of the bladder, urethra, rectum, uterus, nasal fossæ, pharynx, larynx; it is, however, chiefly of use in diseases of the urethra, to which its construction is especially adapted.

It consists of a tube or speculum of hard rubber[1] (Fig. 722), which is introduced into the cavity to be examined; and at one extremity of this a mirror of polished silver, perforated in the centre, is placed at an angle of 45°, to reflect the light, which is placed laterally, in the tube, so as to illuminate it to the end; as the calibre of the tube is very small, a most brilliant light is required, and in order to obtain the best effects, it should be made to converge slightly upon the mirror, by interposing between the light and mirror a plano-convex lens of suitable focal length. The light being sufficient, the lens properly adjusted, the mirror bright and correctly placed with respect to the tube, the eye of the observer, looking through the perforation in the mirror, can see clearly to the speculum [illegible] The meatoscope (Fig. 723) is for examination of the parts within an inch or more of the meatus.

Fig. 723.

Meatoscope.

The circumference of the flaccid penis generally bears a certain relation to the capacity of the urethral canal; by taking the measurement of the former the calibre of the latter can be very closely approximated before instruments are introduced.[1]

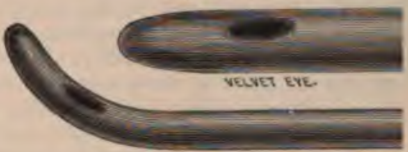
The following relations have been noted:[1] Penis 3 inches, canal 30, of the French scale; penis 3¼, canal 32; penis 3½, canal 34; penis, 3¾, canal 36; penis 4, canal 38; penis 4¼ to 4½, canal 40 or more. In every case the urethral calibre is over rather than under these figures.

---

[1] F. N. Otis.

The catheter, sound, and bulbous bougie are necessary to determine the condition of the urethra. One of the most convenient forms of catheter is the velvet-eyed (Fig. 724), which is yielding, and creates no irritation. The sound detects the presence of solid bodies, as calculi; the bulbous bougie measures the calibre and extent of strictures. An olive point may be fixed on the extremity of a stilet, in a spiral tube or catheter; the catheter is introduced with the bulbous extremity withdrawn, but when it is arrested the bulb is protruded through strictured points.

Fig. 724.



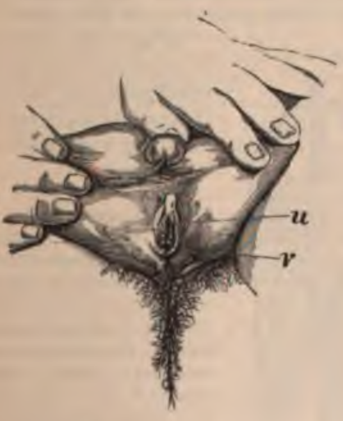
Soft catheters.

II. DEFECTS OF URETHRA.

Imperforate urethra[1] may consist of a closed meatus, which must be opened by puncture or incision; or of a diaphragm lower down, which must be perforated by a trocar. If the tube is deficient throughout, the bladder must be opened by perineal section, and an effort must be made to construct a permanent passage.

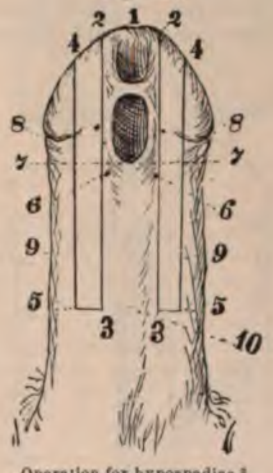
Hypospadias[2] is the result of deficiency of the lower wall of the urethra, and may occur at any part of the penis; in the scrotal form the orifice is often abnormally large, and the parts resemble those of the female (Fig. 725); the most frequent location of the orifice is just behind the glans, but the most serious defects are posterior to this point. In some cases there is a shortening or retraction of the corpus

Fig. 725.



Hypospadias.

Fig. 726.



Operation for hypospadias.[3]

---

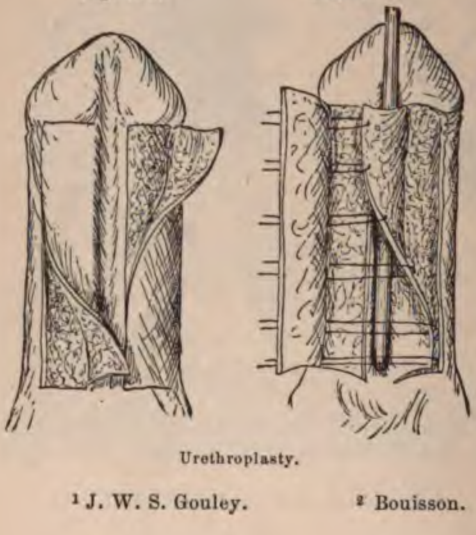
[1] Sir H. Thompson. [2] T. Holmes. [3] J. W. S. Gouley.

spongiosum and fibrous envelopes of the corpora cavernosa, causing incurvation of the penis, especially during erection. Treatment of hypospadias is advisable only when it appears to be inconsistent with the power of impregnation, or when the opening is so small as to afford a real obstacle to the passage of the secretions. When the defect is in the balanic portion, the following operation[1] will prove most satisfactory (Fig. 726): Make longitudinal incisions 2, 3, sufficiently far apart to leave ample material for the new urethra, and 4, 5, one-quarter of an inch outside; dissect the integuments from the spaces bounded by these incisions; preserve intact the mucous membrane and skin in all the central space included between the incisions 2, 3, and 1, 10; slide the loose skin at the root of the penis and of the scrotum gradually forward, making it double upon itself until 3, 3, is brought to 2, 2, and the denuded surfaces are brought into accurate apposition, making the angle of the fold at 7, 7; take the first suture at 6, 6, passing the upper from within outwards and the lower from without inwards; before tying the suture of one side, pass that of the opposite side, tie and cut the ends short leaving the knot inside of the newly formed urethra; apply sutures along the external side at 3, 5, 9, and 2, 4, 8. The meatus becomes transverse, its inferior lip being the fold of skin from 10, formed by the apposition of the points 3, 3 to 2, 2, and its superior lip the edges of mucous membrane 2, 2. When the opening is behind the glans, and the organ is otherwise well formed, no operation is required, or at least only a freshening of the edges and their union by suture; if the opening is in the penile portion, and the organ is incurved, the latter must first be relieved by subcutaneous section of the tense fibrous structures, while the organ is forcibly extended; slight transverse incisions of the skin may be required, and when the penis is extended these incisions will become longitudinal, and may be united by suture in this form.[2]

When the opening is in the penile portion, urethroraphy and urethroplasty have been successfully practised, as follows:—

(*a*) Urethoraphy, or suture of the urethral opening, may be performed when the opening is small, one-fifth of an inch in diameter, oblong, its long diameter being in the axis of the urethra; and its margins easily approximated.[3] The edges should be incised obliquely so as to form an apex at the opening when the stitches were applied; fine wire should be used, the mucous membrane not being included.

Fig. 727. Fig. 728.



Urethroplasty.

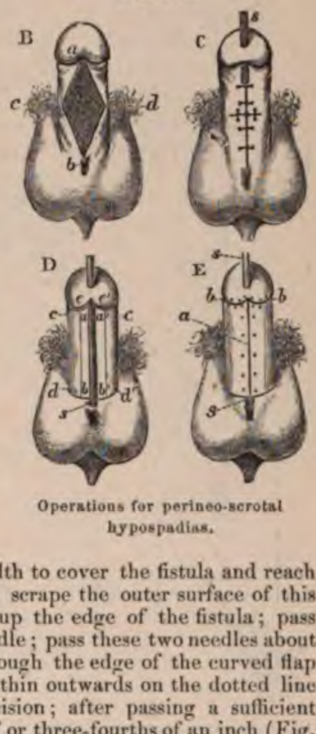
---

[1] J. W. S. Gouley. [2] Bouisson. [3] L. Verneuil.

(b) Urethroplasty has been performed thus:[1] Make an incision on the left side, from the glans to the scrotum (Fig. 727), through the skin, half an inch from the median line and parallel to it; from each end of this incision make oblique incisions to the median line, and dissect up the flap thus formed; make a second longitudinal incision to the right of the median line, but near it, of the same length, and lateral incisions from each extremity an inch and a half, and raise the flap; introduce the sound, and turn the first flap backwards over it, the epidermic surface towards the urethra, and insert sutures in the margin; put each of the ends through the eye of a needle, which must be passed from within outwards through the base of the other flap (Fig. 728), and fastened by shot compressed upon it; the right flap is placed upon the raw surface of the first, and fastened to the margin of the first incision; the catheter is to be removed, but should be introduced to remove the water.

(c) Or[2] the meatus is first restored by paring the two lips of the notch *c*, *d*, *B* (Fig. 729), which represent it, and the pared edges are united over the end of a probe introduced, *C*, *s*; then two longitudinal incisions are made from the glans nearly to the false opening on either side of the median line, and at a distance from it equal to half the circumference of the new urethra, *D*, *a b*, *a′ b′*; at the extremities, transverse incisions are made nearly to the median line, *D*, *c e c e*; *d b′*, *d′ b′*; these flaps are dissected from without inwards, and raised towards the median line so as to completely cover a sound of convenient size previously introduced through the newly-formed meatus *D*; next, the skin at the sides is dissected up and drawn towards the middle line to cover the denuded surface *E*; the two layers of skin are united in the middle line, and the upper margin of each flap to the lower margin of the glans, after paring; the scrotal fistula is pared and united to the newly-formed canal, *E*, *a b b*.

Fig. 729.



Operations for perineo-scrotal hypospadias.

(d) Or,[3] make an incision near the edge of the fistula and extending beyond it three-eighths to one-half an inch at each end, 1, 1 (Fig. 730), and dissect up a flap bounded by the dotted curved line. Make a curved incision on the opposite side, and extending nearly to the points of the first incision, and broad enough to include a flap of sufficient width to cover the fistula and reach the dotted curved line when turned on itself; scrape the outer surface of this flap to remove the epidermis, and dissect it up the edge of the fistula; pass each end of a thread through a fine curved needle; pass these two needles about one-quarter to one-sixth of an inch apart through the edge of the curved flap from the epidermic surface, and then from within outwards on the dotted line border of the flap formed by the straight incision; after passing a sufficient number of these sutures, one to every one-half or three-fourths of an inch (Fig. 731), draw the curved flap under the straight one into the space formed by dissecting up the latter, so that its edge will correspond to the dotted curved line, and secure them over a piece of cork: then pass sutures across the uncovered space; uniting the edge of the straight flap with the skin on the edge of the curved incision (Fig. 732), and secure them.

[1] T. Anger. [2] S. Duplay. [3] Szymanowski.

Fig. 730.

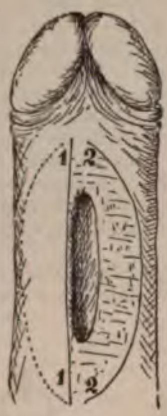


Fig. 731.

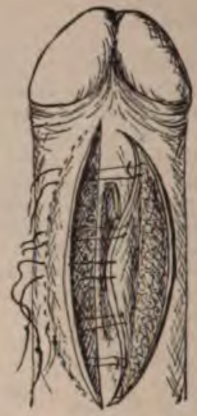
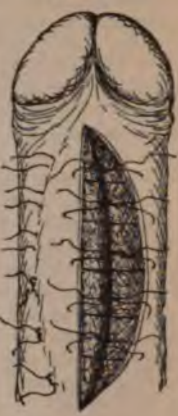


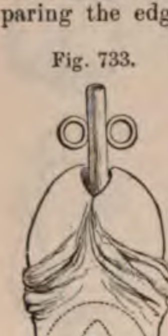
Fig. 732.



Operation for large fistula.

In small fistulous openings the closure may often be effected by paring the edges, loosening the adjacent skin by dissection for an inch around the fistula, bringing the parts into apposition by deep quilled suture[1] (Fig. 733).

Fig. 733.



Urethroplasty in small fistula.

Epispadias, defect in the upper wall of the urethra, is frequently attended with other deficiencies of the neighboring parts; it may be a slight fissure, or may extend from the glans nearly to the bladder; operations for its relief have generally failed. The following method deserves trial:—

The operation[2] requires several sittings. To make the meatus and parts belonging to the glans, two incisions are required, one on each side of the groove; the surface of the outer lip of each incision is pared, and the fresh surfaces are united with the twisted sutures. To make the urethra, an incision is required along the groove on the right side, and traverse incisions at its two extremities. On the left side, a similar incision is made but three-fourths of an inch from the groove; this flap is dissected up and turned over to form a roof for the new urethra, its cutaneous surface being turned downwards; ligatures are passed near its free border and then through the base of the other flap, which is drawn over the first so as to bring their raw surfaces together; the anterior space between the new urethra of the glans and of the body is closed by making a transverse incision through the prepuce, passing the glans through it, and paring the borders and attaching them to the edges of the incision of the prepuce; the posterior portion of the canal is closed by flaps from either groin, in the same manner as the urethra, one being reflected to form the urethra, the other to cover the first flap; the edges of the old flaps being refreshed.

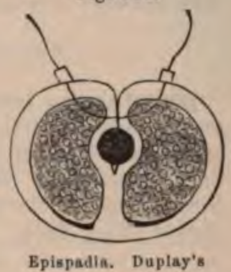
---

[1] E. Nélaton.

[2] Thiersch.

Or, avoiding skin flaps,[1] a surface on each side may be denuded the entire length, including the glans; these surfaces are placed in apposition over a catheter, and united by a quilled suture, consisting of single fine wires, passed through a leaden tube on each side, and fastened by compressed shot (Fig. 734).

Fig. 734.



Epispadia. Duplay's method.

III. INJURIES.

Simple incised wounds[2] are dangerous in proportion to their depth, as regards their direction and the tissues involved. The indications are, to prevent extravasation of urine by enlargement of the wound if necessary, or the introduction of a catheter.

Contused and lacerated wounds generally result from falls astride of hard bodies, and are more frequently located in that portion related to the deep perineal fascia, and it is in this part that there is the greatest risk to life, owing to the tendency to urinary infiltration, and the liability to intra-pelvic suppuration and peritonitis.[2] The rupture is usually due to the forcible pressure of the urethra against the triangular ligament.[3] The tube may be torn partially or completely across. The symptoms may be very slight, but generally there are contusions, inability to pass water, and bleeding from the urethra. At first, an effort should be made to pass a flexible catheter, but the utmost gentleness must be used, in order not to engage the point in the rent; if the rent is longitudinal, the catheter may pass without much difficulty:[4] if it is transverse, and involves only the lower portion, the extremity of the catheter may be passed along the roof; in some cases the stilette may be carried in the flexible bougie, and when the obstruction is met with by withdrawing the stilette an inch the end of the catheter is suddenly raised and passes the obstruction. The catheter should rarely be retained owing to the liability to extravasation by its side.[2] If there is hemorrhage, ice must be applied. If the catheter cannot be passed, or there is a distinct hard tumor at the seat of injury, perineal section must be at once performed to give free escape to the urine; pass a sound down to the rupture, and make the incision upon to its extremity.

Delay in the performance of this operation causes imminent risk, and probably an aggravation of the local mischief.[2] These lesions always render the patient liable to subsequent strictures, often of an intractable kind, and hence the importance of restoring and maintaining the full capacity of the canal in the subsequent treatment.

Laceration of the mucous membrane of the healthy urethra more often results from forced catheterism; the catheter is usually arrested at the triangular ligament, and if force is used the mucous membrane yields and a false passage results.[3] In the strictured urethra, lacerations occur from attempts to force a passage; the point of the catheter passes on the side where pressure is greatest. These lacerations may lead to infiltration, and then incisions are required, especially when the wound is in the perineal portion; ordinarily, the false passage becomes a part of the treatment of stricture.

---

[1] S. Duplay.

[2] J. Birkett.

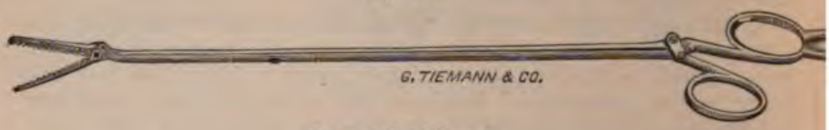
[3] J. W. S. Gouley.

[4] S. Rogers.

IV. FOREIGN BODIES.

Substances introduced into the urethra from without include every variety of materials, as pins, pencils, stones, beads; they tend to advance into the bladder, but, if arrested, they cause retention, and finally ulceration. Immediate removal is necessary. The most useful instrument is forceps with a long handle which separate only at the blades (Fig. 735); for bodies in the anterior part of the urethra, slender forceps, with suitable blades are necessary (Fig. 736);[1] pressure must be made behind the body, if possible, to prevent its being forced backward by the forceps.

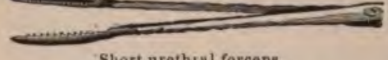
Fig. 735.



Long urethral forceps.

If the body be long and soft, as a cathether or a piece of wood, it may be transfixed with a stout needle through the floor of the urethra and the canal pushed back over it, like a glove over a finger, as far as possible, when it may be transfixed again, and so urged forward until it can be seized at the meatus.[2] If the body cannot be dislodged, it must be removed by a longitudinal incision.

Fig. 736.



Short urethral forceps.

Calculus, or an angular fragment of a crushed stone, may lodge in the urethra in its passage from the bladder. The points where it is most liable to lodge are, (1) the membranous portion, at the triangular ligament; (2) in the middle of the penile portion; (3) at the meatus. If the calculus is posterior to the triangular ligament, push it back into the bladder with a large catheter; if it is immovable without great force, which must be avoided, it may be forced back by injections through the catheter of warm water, olive oil, or flaxseed tea. If the body is anterior to the ligament, it should be withdrawn through the meatus by means of the forceps mentioned; if this effort fail, the three-blade searcher,[3] or trilabe (Fig. 737),[4] should be employed. Introduce the blades withdrawn into the handle, until the calculus is reached; then carefully open the blades, and when expanded gently insinuate them beyond the stone; now close the blades, and withdraw. Other methods are the various forms of scoops (Figs. 738, 739, 743).

---

[1] Sir H. Thompson.

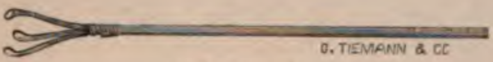
[2] Van Buren and Keyes.

[3] J. Hunter.

[4] Civiale.

The scoop may consist of a female and male blade; the former may be movable, or it may be fixed. The first should be introduced with the scoop straight and the male blade withdrawn (Fig. 739); the scoop must be insinuated by the side of the stone until it passes behind, and then brought to a right angle (Fig. 740); the male blade should then be forced down by means of the screw (Fig. 741), when the stone is caught, and removed or crushed. If the scoop is fixed (Fig. 743), it must be hooked over the calculus.[1] Pass the scoop down to the stone, compressing the penis behind it, 1 (Fig. 742); bend the penis at a right angle, and crowd the point of the scoop along the wall of the urethra, 2, until its point passes around the stone, 3; now turn the screw, force the stylet down upon the stone (Fig. 744), and withdraw it. If the stone cannot be removed by these means, longitudinal incision must be made in the median line.

Fig. 737.



Trilabe forceps.

Fig. 738.[1]

Urethral scoop.

Fig. 739.

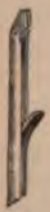


Fig. 740.

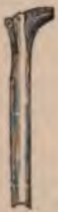


Fig. 741.

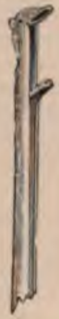
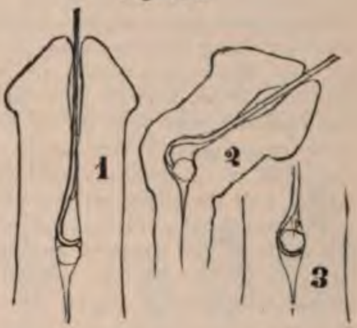
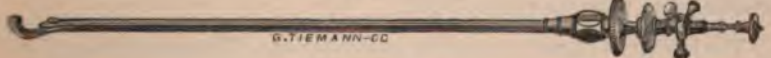


Fig. 742.



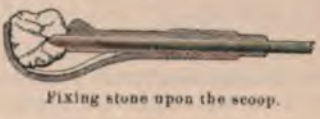
Urethral scoops and their application.

Fig. 743.



Fixed scoop.

Fig. 744.



Fixing stone upon the scoop.

---

[1] Rilequet.

V. STRICTURE.

Stricture is an abnormal contraction of some portion of the urethral canal, which may be transient, from spasm or congestion, and permanent or organic, from deposit in or around the walls of the urethra.[1]

In the correct sense, there can be only the permanent or organic stricture; spasm of the urethra is doubtless of very frequent occurrence, but does not, properly speaking, constitute stricture; in permanent stricture there is often a very decided tendency to spasm, and inflammatory swelling, sufficient to cause retention of urine, not unfrequently occurs in an already constricted canal, but these conditions do not come within the definition.[2]

Spasmodic stricture may be caused by a local lesion, as partial organic stricture, or by excitement existing elsewhere, as inflamed hemorrhoids.[1] Contraction of the meatus and slight organic stricture of the anterior portions of the urethra will cause spasmodic stricture of the deeper parts closely resembling deep organic stricture.[2] The distinguishing feature of this form of stricture is its transient character, and the return of the urethra to its natural degree of patency.[1] The treatment consists in relieving the bladder by a hot bath, rest, and opiates, or at once by an anæsthetic and catheter; the removal of the cause must follow, as the correction of vicious habits, the gouty diathesis, or concentrated urine;[4] the contracted meatus must be enlarged, and the slight stricture dilated.[3]

Permanent stricture results from organic deposit in or around the walls of the urethra, due to inflammation following injuries, or irritants of the mucous membrane. It may vary in the degree of constriction from a slight diminution of the calibre of the urethra, stricture of large calibre,[3] to the almost complete closure of the tube. In ordinary cases, the following forms are recognized, namely, (1) the linear, (2) annular, (3) tortuous. Stricture may occur at any point in the urethra, but in searching for it the natural narrowing of the passage must be remembered.

The locality of organic stricture is variously given. The examination of 2[illegible] museum specimens proves that the order of frequency of strictures is as follows: (1) At the junction of the spongy and membranous portion, and an inch before and three-fourths of an inch behind that point, 67 per cent.; (2) the spongy portion, to within two inches and a half of the external meatus, 16 per cent. (3) within two inches and a half of the meatus, 17 per cent.[1] Measurement by the urethra-meter, in 258 living subjects, give very different results, as follows: in the first quarter of an inch, 52; in the following inch, 63; next inch, 48; next inch, 48; next inch, 19; next inch, 14; next inch, 8; next inch, 6.

The symptoms of stricture depend upon its stage. A chronic urethral discharge is symptomatic of stricture, and should always lead to an examination with suitable instruments;[5] pain is usually felt in the urethra behind the stricture at the time of micturition; urination is increased in frequency, and the stream is altered in form, becoming more or less flattened, perhaps twisted, spirting, forked, or even divided; as contraction increases the stream grows smaller, the force of the current is lost, the act of micturition is more frequent and prolonged; in the worst cases there are almost constant efforts to obtain relief by change of posture and straining, with tenesmus of the rectum and protrusion of the mucous membrane; finally, retention becomes more and more frequent, with the incontinence due to a distended bladder.[1] These symptoms are not sufficient alone to establish the presence of stricture, and it is necessary to explore the urethra; with an instrument, its existence may be ascertained, its location and calibre, and whether more than one is present.[1] It is, however, always necessary, in the detection of slight contractions to know the normal calibre of the urethra in each particular case, for every urethra has a distinct individuality, irrespective of standards, or even of general physical proportions.[2]

---

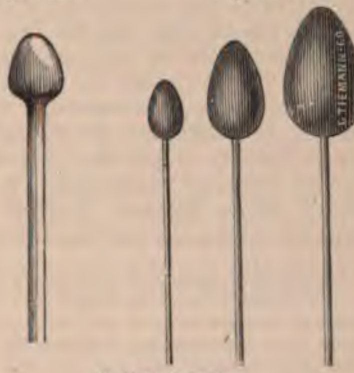
[1] Sir H. Thompson. [2] J. W. S. Gouley. [3] F. N. Otis.
[4] Van Buren and Keyes. [5] H. Dick.

It is a very common error to suppose that when a No. 10 or 12 instrument is passed a patient has no stricture, for one adult may have a perfectly healthy urethra so small as to admit only a No. 8 or 9 sound, while another man's urethra may admit a No. 16, 17, or 18, and be constricted; it is necessary, therefore, to be governed by the normal calibre in each individual case.[3]

Complete freedom from stricture can only be demonstrated by the easy passage of a bulbous sound of a size fully equal to the normal calibre of the presenting urethra; this calibre should first be accurately determined by the urethra-meter, or by the less accurate method of measuring the circumference of the flaccid penis.

The simplest, and best of all the explorers now in use, is the bulbous bougie (Fig. 745), of various sizes which, owing to the flexibility, accommodates itself to the curves of the urethra, and yields to the slightest obstruction, qualities which render it infinitely more delicate than metallic instruments.[3] An instrument of wider range and greater endurance is the bulbous sound (Fig. 746), which consists of a metallic bulb of olive shape, attached to a slender copper shaft; for convenience the bulbs may screw upon a common handle.

Fig. 745. Fig. 746.



Bulbous bougies.

Before commencing the direct exploration of the urethra, it is desirable to see the patient urinate, in order to ascertain the size and force of the stream; the glands should then be examined, and the position and size of the meatus ascertained.[3]

Contractions of the meatus are a fruitful source of failure to appreciate abnormal narrowings of the urethra; the complete suppleness and resiliency of the tissues of the normal meatus is a good test of its freedom from organic stricture, but congenital contractions to a greater or less extent are not infrequent; hence both the natural suppleness and resiliency may be present, and the deformity may escape notice, unless carefully sought.[1]

---

[1] Sir H. Thompson. [2] F. N. Otis. [3] J. W. S. Gouley.

As a rule, whenever a bulbous sound can, by gentle pressure three or four minutes, be made to slip into the fossæ navicularis, and in the withdrawal is abruptly arrested, the indication for the free division of the meatus is positive, for without it no efficient exploration of the deeper parts can be effected.[1] The meatus must be enlarged by an incision on the inferior wall of the canal with a bulb-pointed bistoury, and to an extent which will allow the passage of the bulbous sound with the utmost freedom:[1] Now, introduce a well-oiled instrument, as large as the orifice will admit, and pass it slowly along the canal till it meets an obstacle which presents a positive hindrance to its progress; mark the stem of the bougie with the nail, and withdraw and measure to ascertain the location of the stricture, select a smaller instrument and pass it beyond the obstacle; on withdrawing the bulb the base will present at the vesical extremity of the stricture; if the measurement is repeated and the difference is added to the length of the smaller bulb, the length of the stricture will remain; these bougies aid in ascertaining the form, diameter, and number of strictures, the tender spots in the urethra, and the presence of pus.[2]

Stricture should be cured at every stage, for if the balance between the natural expulsive force of the bladder and the friction of the stream along the urethra are disturbed, the bladder is irritated, the kidneys are affected, and the beginning of the long chain of events, which terminate not infrequently in death, is made.[3] Treatment is directed (1) to restore the natural calibre of the canal, and (2) to maintain its adequate patency; as strictures vary in amount of contraction, in dilatibility, in disposition to return, in local sensibility, and in liability to manifest sympathy with other parts of the body, various modes of treatment are necessary and appropriate to different cases.[4] These different methods will be appreciated in connection with special degrees and conditions of stricture.

In operating upon strictures, every case,[1] whether of division of the meatus or of the deeper urethra, should be treated as though hemorrhage must surely occur, so that the surgeon may not be taken unawares; make a point of never, under any circumstances, dividing the external urethral orifice without being thoroughly satisfied that the case will be taken care of for three or four days, although no bleeding may occur at the time of the operation. In cases of division of the orifice alone, take a couple of pieces of pasteboard, and apply these on each side of the penis, retaining them either by rubber bands or by means of a bandage with the end divided into four or six tails; this apparatus, in favorable cases, need be retained but a very short time, but should be adopted when hemorrhage recurs during urination and erection. When the hemorrhage is deep down anywhere in the pendulous portion of the urethra, it is usually sufficient to put an ordinary bandage around the penis; but it is always well in such cases to make a little pad and put it in the perineum, and take a stick, the end in the shape of a crutch, to pass from the foot of the bed up to the perineum, that, if necessary, the patient may make pressure against the pad in the perineum, so as to occlude the urethra at that point, and thus prevent the blood from going back into the bladder. Staining of the urine drawn off directly through the catheter, and subsequent vesical tenesmus, indicate that there has been bleeding into the bladder. This accident is not likely to occur when the division has not been made further back than four inches from the orifice, but it is not infrequent when the cut is at or beyond four inches. Therefore it is desirable to have an apparatus which can always be easily extemporized, which will secure the patient against hemorrhage into the bladder. All that the surgeon will then have to do is to make pressure at some point anterior to the cut. In cases of much bleeding after interior urethrotomy, take an ordinary gum-elastic tube, or some other tube with an open end, and pass it down beyond the cut, retaining it by means of a bandage. If the presence of the instrument cause discomfort, it can be removed, but, as a rule, the patient will bear it long enough to arrest the hemorrhage. If this method fail, introduce an ordinary catheter beyond the cut, making pressure on the perineum, and then gently inject water at a temperature of 120° F., or carry the temperature up to 125°.

---

[1] F. N. Otis. [2] J. W. S. Gouley. [3] B. Hill. [4] Sir H. Thompson.

Strictures at or near the meatus[1] should be treated by division on the inferior wall of the canal, with a straight bulb-pointed bistoury; the utmost freedom to the passage of the bulbous sound must be obtained, and not a single trace of contraction left uncut. Means must be used to prevent inflammation, as rest, and cold water applications.

Strictures of large calibre, or incipient strictures, in the pendulous urethra, must be treated by a process of divulsion and urethrotomy which results in a complete rupture or division of every fibre of the contraction; no one instrument can ever be depended on to succeed completely in all cases; in ordinary stricture the dilating urethrotome is more easy of management.

It consists of a dilating apparatus which, when closed, is equal to about twenty of the French scale; upon its superior aspect a blade, guarded at the top, is slid down through a groove to the end of the shaft; the screw at the handle is then slowly turned until the handle on the dial indicates that the instrument is dilated up to two or three millimetres beyond the previously ascertained normal calibre of the canal; the blade is then slowly withdrawn, cutting through all the stricture on the superior wall of the urethra; the instrument is now withdrawn and a full-sized bulb passed; if any fibres of the stricture remain, the operation must be repeated at the contracted point until perfect freedom is secured.

Cold should be applied as before, and sounds may be passed to separate the cut surfaces, not to cause dilatation, but their use must be discontinued as soon as a full-sized bulb can be passed through and beyond the previous site of the stricture and withdrawn without a trace of blood.[1]

Recontraction of stricture, after operation, is due to incomplete division, and this will, as a rule, be detected within one week, or, at most, two weeks, by which time the stricture tissue distended, and not divided, will sufficiently recontract to become readily recognizable by the full-sized bulb.[1]

Strictures of a calibre of less than 16 or 18 of the French scale, or 7 or 9 of the English, require enlargement by gradual dilatation with soft bougies, when they are well borne, but if not, by divulsion; after having been brought up to a capacity permitting the passage of the dilating urethrotome, complete division of the stricture should be effected by means of that instrument.[1]

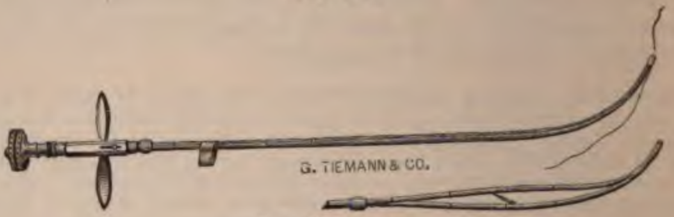
---

[1] F. N. Otis.

Dilatation is the mildest and most desirable treatment, being generally applicable, and best adapted to a very large proportion of cases; in ordinary cases a flexible bougie, as large as the stricture will easily admit, should be passed fairly through it, and then at once withdrawn with gentleness; in two or three days it is repeated, and if the bougie passes with ease, one of larger size must be introduced; gradual advance must then be made until 12 or 13 can be passed.[2] But dilatation, temporary or persistent, is never more than a palliative measure, unless carried to a point sufficient to completely rupture the stricture.[1]

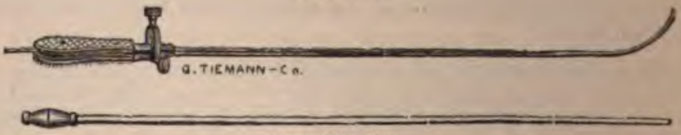
To treat a stricture by divulsion is to make a longitudinal rent of the constricted portion of the urethra; this may be accomplished by the successive introduction of conical sounds, of different sizes, which act on the principle of a wedge, or by any of the various divulsors.[3] There are three instruments well suited for the treatment of stricture by this method,[4] namely: (1) The first[2] consists of two parallel blades, slightly curved towards the beak at which they are joined; the blades may be separated laterally to the desired extent by turning the handle; the shaft is marked by lines one inch apart to indicate the depth to which it penetrates. This instrument, as modified, by reducing the size of the shaft and tunnelling the beak (Fig. 747), so that it may be introduced through small strictures, is to be preferred.[3] In using this instrument the depth of the stricture must first be accurately determined by the bulbous bougie; the metallic slide is then pushed down upon the closed instrument until its point of greatest dilatability equals the distance from the meatus to the centre of the stricture; no anæsthetic is required; pass the instrument into the urethra until the meatus is touched by the slide, and the greatest dilatibility corresponds to the centre of the stricture; now turn the handle rapidly until the blades have been separated to an extent several sizes larger than the

Fig. 747.



Tunnelled divulsor.

Fig. 748.



Lateral divulsor.

---

[1] F. N. Otis.

[2] Sir H. Thompson.

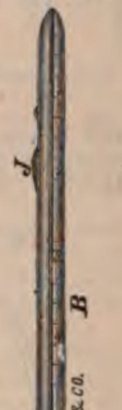
[3] J. W. S. Gouley.

[4] Van Buren and Keyes.

patient's meatus will admit; the failure of the operation is due to the employment of too little force; it is better to tear too much than too little, as it is only the stricture which yields; the flow of blood is evidence of rupture.[1] (2) The second form of divulsor[2] consists of two grooved blades fixed in a divided handle (Fig. 748), containing a wire welded to their points; on this wire a tube corresponding to the natural calibre of the urethra is quickly passed and ruptures or splits the obstruction; the instrument should first be passed into the bladder, when a few drops of water will escape, then place the tube selected on the wire and thrust it quickly onwards to the end, now rotate the shaft and withdraw it, and substitute a catheter of equal size. (3) The third form[3] resembles the second in having two parallel blades, but they act by fitting into grooves of solid conical and cylindrical shafts; the blades are first introduced closed, and then the shaft selected is fitted into the grooves and driven forcibly home, separating the blades laterally.

The defect in these instruments is their want of adaptability to the dimensions of the stricture upon which operation is required; the amount of resiliency of the stricture in the flaccid urethra is undetermined, and hence the divulsing shaft is selected without exact data, and the size of the blade in the cutting instruments being left to conjecture is liable to be unsuited to the case.[4] There is, therefore, need of an instrument which will supplement the other divulsor and prove reliable in the complete division of the stricture and the enlargement of the calibre of the urethra to its full normal capacity. This is found in the following dilating urethrotome (Fig. 749):[4] A pair of steel shafts, *A*, *B*, are connected by short pivotal bars; the expansion and contraction are effected by means of a screw in the handle, connected with the lower shaft, and moved by a finger button, *C*; short curved registering arms, at *D*, mark the divisions of the American and French scale; a scale of inches and quarter inches are marked on the shaft, *B*, by which its depth in the urethral canal is rated; the upper bar of the instrument is hollowed out, and traversed by a urethrotome; by the metallic handle, *G*, of the urethrotome, it is moved at will through the entire length of the shaft, *A*; a small button, *H*, secures the canula at any point; running through the canula, and attached to the handle, *I*, is the staff of the urethrotome, which, when at the extremity of the canula, is concealed in the deep groove; on withdrawing the handle, *I*, the canula being firmly fixed at any given point by the button-screw, *H*, the spring blade, *J*, rises out of the groove by means of a little elevation on its floor, rides over it, displaying the full width of its blade for half an inch, then drops into the groove and is concealed. The instrument is used as follows: Introduce it with the urethrotome beyond the known point of stricture. Now dilate the shafts, *A*, *B*, until the stricture is made tense; turn the button-screw, *H*, releasing the canula, which must be drawn outwards until the knob of the urethrotome, beyond *J*, is arrested; the canula is then advanced half an inch, and fixed, and then by a rapid movement outward of the handle of the urethrotome the blade is brought up through the stricture from behind forwards; the finger-button, *C*, is again turned and the shafts separated, to determine whether the stricture is completely divided; if not, the knife may be passed from before backwards.

Fig. 749.



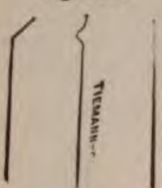
Urethrotome.

---

[1] Van Buren and Keyes.
[2] B. Holt.
[3] Voillemiers.
[4] F. N. Otis.

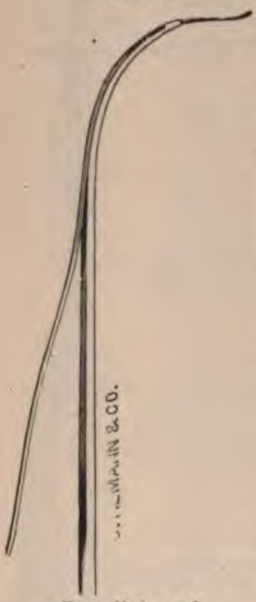
Small strictures with tortuous or false passages require the use of filiform bougies, as guides to other sounds; these guides are made of whalebone, of various sizes down to that of a horsehair; they are ordinarily twelve inches long, with straight, angular, and spiral points (Fig. 750). They are used as follows:[1] Inject oil into the urethra; then introduce the bougie, straight or bent, along the floor of the canal to avoid the lacuna magna; if it enter a lacuna, withdraw, and change the direction; in exploring for the entrance of a stricture, a slight to-and-fro motion should be given; if the effort fail with one form, another must be substituted, and the whole calibre of the urethra must be examined; if the sound has passed the stricture, it will be movable back and forth; if it enter a false passage, allow it to remain, and pass others by its side until one passes on into the bladder. Having reached the bladder, the bougie serves as a conductor upon which the tunnelled sound (Fig. 751), may pass, and both dilate and straighten the stricture.[1]

Fig. 750.



Filiform bougies.

Fig. 751.



Tunnelled sound.

The tunnelled sound[2] is a grooved, conical steel sound with a canal one-eighth of an inch in length at the vesical extremity, and with a curve equal to one-fifth the circumference of a circle three and one quarter inches in diameter; the smallest is one and a half millimetres in diameter at the point; when the guide has entered the bladder, the free end is slipped through the tunnel of the smallest sound, which is carried down to the obstacle, and held in firm contact with it for a few moments, when the instrument will pass, but no undue pressure should be used; larger instruments should be passed at the same sitting, up to four or five higher numbers.[1] The stricture may now be fully dilated by the dilating urethrotome.[1]

VI. INTERNAL AND EXTERNAL PERINEAL URETHROTOMY.

In many obstinate cases, incision of the stricture becomes a necessary and important part of the treatment. This incision may be (1) internal, internal urethrotomy, or (2) external, perineal urethrotomy.

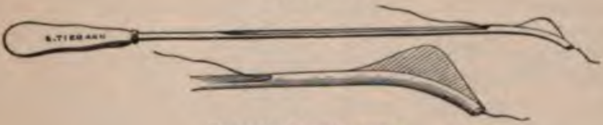
Internal urethrotomy is performed with a great variety of instruments, but they may be usefully classified into those adapted (1) to the smallest stricture, and (2) to strictures of the calibre of Nos. 4, 5, or 6. For the former, use the tunnelled urethrotome (Fig. 752),[2] as follows:[2] Pass the capillary conductor into the bladder; slip the distal end through the smallest tunnelled sound, and dilate the stricture a little to facili-

[1] J. W. S. Gouley.

[2] F. N. Otis.

tate the entrance of the urethrotome; remove the sound, and introduce the tunnelled urethrotome, and divide the stricture from before backwards by sliding the instrument gently upon the conductor until all resistance to its passage ceases; withdraw the urethrotome, leaving the conductor in position; now pass a large tunnelled or other catheter to ascertain if the incision has been sufficiently free.[1] The stricture may be divided from behind forward, but to make this incision, the stricture must admit the part of the instrument concealing the blade; this requires the dilatation of the stricture to No. 3, or 4.[2] But when dilation has reached that degree, the principles which govern in resorting to the dilating urethrotome in strictures of large calibre should be applied to these strictures of small calibre.[1] The instrument for this operation combines dilatation with incision;[3] its application is apparent.[1]

Fig. 752.



Tunnelled urethrotome.

External, or perineal, urethrotomy is required when dilatation is unsuccessful, or impracticable, or there are fistulous passages. In some cases it may be possible to pass a grooved staff through the stricture, which greatly simplifies the operation; in other cases the stricture is so light as to admit only a filiform bougie, which is an important guide, but a certain number are altogether impassable, and the section may be made without a guide For several days before the operation, when there is no urgency, it is well to direct the patient to assume the recumbent position and take a hip bath every night, also ten drops of tr. ferri chloridi three times daily, and five grains of quinine at bedtime, with a suppository of one grain of opium and half a grain of the extract of belladonna every night; the bowels must be moved by oil and an enema before the operation.[1] Operate as follows: After filling the urethra with olive oil, introduce a capillary probe-pointed whalebone bougie into the urethra; if its point enter a false passage, pass others by its side until one enters the bladder; upon this guide pass a tunnelled groove staff into the bladder; by the rectum explore the membranous and prostatic divisions of the urethra; now make a free incision in the median line of the perineum, extending from the base of the scrotum to within half an inch of the anus, involving skin and superficial fascia; continue the dissection until the urethra is brought into view; open the canal upon the groove of the staff, pass a thread of silk through each edge of the incised urethra with which the wound may be kept open by an assistant; with a beaked, narrow, straight bistoury, passed along the guide, divide the stricture and half an inch of the uncontracted canal behind it; now pass the catheter, guided by the whalebone bougie, into the bladder; if it is obstructed, extend the incision. The after-treatment should be ten grains of quinine and one-fourth of a grain of morphia immediately to prevent fever; three grains of quinine, daily, with iron, for two or three weeks, and warm hip baths; on the second day a full-sized conical steel sound is passed, and repeated every third day until the wound is healed.

---

[1] J. W. S. Gouley. [2] Sir H. Thompson. [3] F. N. Otis.

If the stricture is impassable, pass a large sound until it rests upon the face of the stricture; an assistant holds it firmly and draws the scrotum upwards; the dissection is the same as the preceding, until the sound is exposed; insert threads into either margin of the urethra with which to keep the wound open; with small grooved directors search for the contracted passage, and, if found, pass the director as far as possible and enlarge it by incision; continue this method of dissection until the passage is complete; if the director cannot be introduced, make the dissection accurately in the line of the canal; as soon as the continuity is restored, introduce a full-sized sound; repeat the passage of the sound, as before, but do not allow it to be retained.

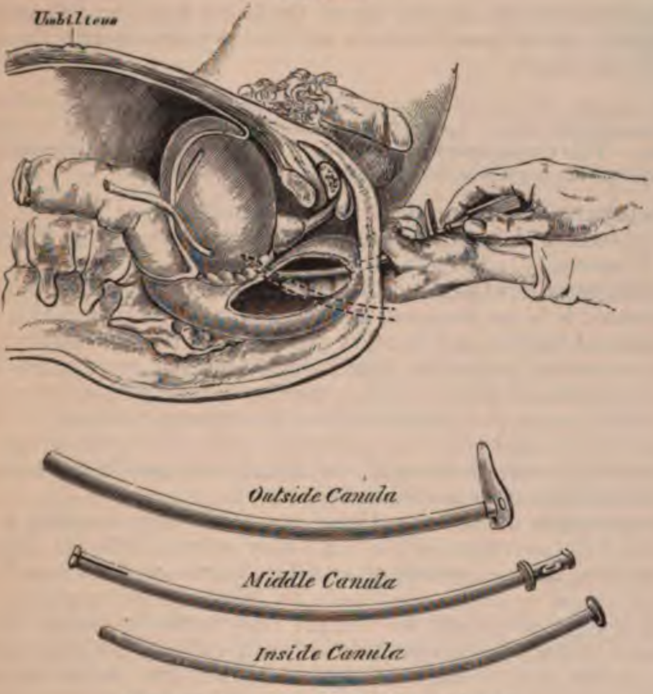
VII. RETENTION OF URINE.

Retention of urine may be due to injuries, or strictures of the urethra, or atony of the bladder, and require immediate relief. If retention is due to injury, or to a stricture which has been injured by efforts to pass a catheter, and relief is imperative, the bladder may be punctured through the rectum, or above the pubes, or through the perineum.

Puncture through the rectum (Fig. 753) is as follows: Place the patient in the lithotomy position with the nates near the edge of the table; introduce the index-finger of the left hand into the rectum, palm upwards, recognize the bulging base of the bladder and the prostate; maintaining the end of the finger in the median line just below the spot where the puncture is to be made; with the right hand pass a blunt trocar and canula, well oiled, along the finger to the point selected for the puncture; now maintain the canula in position with the thumb and three outer fingers of the left hand, and withdraw the blunt trocar, and introduce the sharp trocar through the canula; when it reaches the end at the bladder depress the handle with the canula, and puncture the bladder in a line towards the umbilicus, the dotted line, withdraw the trocar and press the canula home. The two inner canula may be inserted, and the whole fastened by tape; a plug should be inserted to prevent the flow of urine; the canula should be retained until the urethral passage is restored; the inside canula can be removed and cleansed.

Supra-pubic puncture is readily effected, as follows: The bladder being fully distended, it has left a well-defined space, uncovered by peritoneum, just above the pubes. Make an incision upwards, half an inch, commencing at the symphysis, through the skin; select a large aspirating needle, and, having oiled it well, insert it downward and backward with a boring motion; when it is felt free in the bladder attach a common bulb syringe, and pump out the contents; when the bladder is empty, withdraw the needle and dress the wound with iodoform gauze; repeat the operation if necessary.

Fig. 753.



Operation of puncturing the bladder per rectum.

Tapping the urethra at the apex of the prostate by perineal incision[1] is a rapid method of relieving the distended bladder in impassable stricture, as follows: Place the patient in the lithotomy position; introduce the left forefinger into the rectum and place its tip on the apex of the prostate: plunge a double-edged knife into the median line of the perineum, and carry its point forward towards the tip of the finger, enlarging the external wound by an upward and downward movement; when the point is felt near the finger's end, it is made to open the urethra by a slight movement to the right or left; now withdraw the knife, and introduce a probe or director into the urethra and thence into the bladder; withdraw the finger from the rectum, and, holding the director with the left hand, pass a large catheter into the bladder. This new opening may be made permanent;[1] or the stricture may be cut through in front, a catheter passed, and a new urethra established.[2]

VIII. THE FEMALE URETHRA.

Catheterism of the female urethra is effected as follows: The patient lying on the back, completely covered, with the knees flexed, sit, if convenient, upon the right side; holding the short catheter, well oiled, between the thumb and second finger of the right hand, the point resting near the tip of the index finger, pass the hand under the thigh, carry the index finger between the labia to the entrance of the vagina, where the meatus will be detected as a slight elevation with a central depression; as the tip of the finger rests on the posterior edge, glide the catheter forwards and into the meatus with the thumb and second finger.

---

[1] E. Cock.

[2] C. J. Guthrie.

Or, the gum-elastic catheter may be used, which must be introduced with the left hand carried above the thigh, after the right index finger has detected the meatus. This simple operation may prove very difficult and embarrassing, and exposure of the parts may be necessary for its completion.

Stricture may occur from injury, gonorrhœa, or chancre, and is usually located near the meatus. It must be treated by dilatation, and, if necessary, add incision.

Prolapsus urethræ[1] consists of prolapse of the urethral mucous membrane; it is not frequent, but causes considerable irritation of the urethra and bladder, and is often mistaken for irritable caruncle. It appears as a red projection, encircling the meatus, more or less sensitive, and liable to bleed; it may exist for a time without symptoms, but finally causes painful micturition, leucorrhœa, and local irritation. Apply cocaine and seize the prolapsed circle with tooth-forceps, and cut it off with curved scissors. Or, include the mass in ligatures; or, use the galvano-cautery with wire.

Carunculæ of the urethra[2] are small very vascular tumors covered with pavement epithelium; they arise at different depths in the urethra, have a pedicle of variable length, and are usually uniformly round or oval; they may be lobulated or raspberry like; rarely several carunculæ are found; they occur in young and old women. They may be mistaken for small villi, but are distinguished by a pedicle and by their bright red color. The more disturbing symptoms are constant desire to urinate, painful micturition, and excessive tenderness. The treatment is excision. The attempt to remove these bodies must be deliberately made, as they are very friable; first apply a four per cent. solution of cocaine. While an assistant holds the vulva apart seize firmly the growths with forceps and with the scissors cut them cleanly away; no cautery is required.

External urethrotomy, the button-hole operation,[3] consists in opening the urethra upon a metal sound introduced; the point of incision is nearly in the centre of the space between the meatus and the neck of the bladder; the patient should be fully etherized and placed on the left side. After the incision, the wound may be enlarged in either direction. The urethral mucous membrane should be attached to the vaginal surface with catgut. The operation may be performed with scissors made for the purpose.

[1] T. G. Thomas. [2] H. Fritsch. [3] T. Emmet.

X.

THE ORGANS OF GENERATION.

THE MALE ORGANS.

CHAPTER LV.

THE TESTICLES.

THE testicles are two glandular bodies which secrete the spermatic liquid, and are suspended within the scrotum, one on each side, by the spermatic cords.[1]

I. THE SCROTUM.

The scrotum is the pendent pouch below the pubes containing the testicles; the skin is thin, darker than elsewhere, more or less wrinkled, and marked in the median line by a slight ridge, the raphé; the inner portion of the skin is composed of pale and unstriated muscular fibres, the dartos.[1]

Contusions of the scrotum[2] are chiefly remarkable for the large quantity of blood liable to be effused beneath the skin. When the contusion is severe, and the extravasation considerable, inflammation sometimes arises and even terminates in suppuration. All the treatment required, if the testicles have escaped injury, is rest, support with a bandage or pillow, and a lotion of muriate of ammonia, or a poultice of oatmeal and vinegar.

Lacerations of the scrotum[2] though formidable in appearance, usually terminate favorably; there is no hemorrhage, but, owing to the contractile nature of the integuments, the wound gapes and the testicles protrude. Cleanse the wound with bichloride solution, remove coagula, return the testicles, and close the wound with sutures and apply iodoform dressings; protect the parts from urine by oiled silk, secure rest, and the application of cold.

Diffuse inflammation of the scrotum[2] occurs in two forms. (1) The mild form begins as a light erythema and terminates favorably under gentle antiphlogistic treatment. (2) The more severe form runs a rapid and dangerous course and tends quickly to mortification, with typhoid symptoms; it attacks persons of a cachectic habit and broken down constitution. The treatment is prompt incisions into the distended connective tissue to relieve tension; hemorrhage must be prevented by filling the wounds with dry lint; carbolized water dressings should then be applied, or light poultices. The general treatment must be actively tonic and stimulating.

---

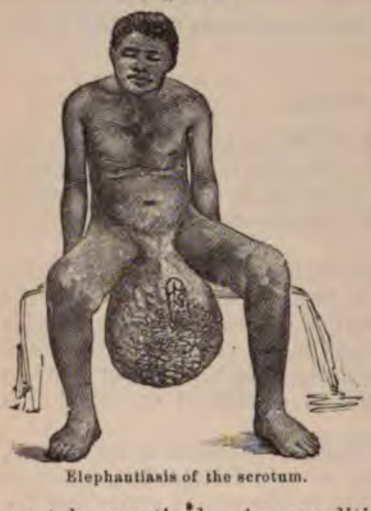
[1] J. Leidy.

[2] T. B. Curling.

Mortification of the scrotum[1] is the result of the preceding inflammation or of urinary extravasation. This sloughing is not free from danger, but in general the extension of gangrene may be arrested by free incisions, and thorough cleansing of the parts with bichloride solution, iodoform dressings; tonics and stimulants should be given freely. Fortunately there is no part of the body in which the reparative efforts are more remarkable after extensive mortification; even when the whole scrotum and part of the integument of the penis have sloughed away, granulations have rapidly sprung up from the exterior of the tunica vaginalis and investments of the cords, cicatrization has advanced from the surrounding skin, and the testicles and spermatic cords have become, in time, invested with a new covering adequate to their protection.

Elephantiasis of the scrotum (Fig. 754) is a disease peculiar to hot climates. It commences as a hard kernel under the skin, usually at the bottom of the left side of the scrotum; as it spreads in all directions, the skin over it becomes thickened and indurated, and appears furrowed, wrinkled, and glandular; the lower part of the abdomen is elongated by the traction of the skin; for the same reason, the penis diminishes in length.[2]

Fig. 754.



Elephantiasis of the scrotum.

In the later stages the ruptured lymphatics allow lymph to transude from their extremities or walls which forms crusts; the tumor becomes altered in appearance and form, being smooth in contact with the thighs, and narrow above where it is attached to a sort of stalk, and large below, descending sometimes below the knee.[3]

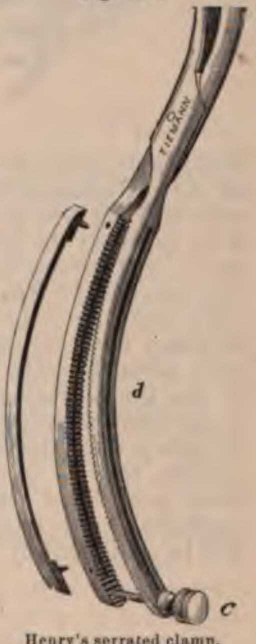
Removal of the mass, when it becomes a great inconvenience, must be practised. As expedition is of the greatest moment, the question of preserving the penis and testicles must first be positively determined.[1] The penis may generally be dissected out and saved, but when the tumor exceeds fifty pounds in weight, the testicles should not be saved.[4] The elastic bandage should be applied to the mass and firmly fastened around the pedicle and hips. The penis should first be dissected out from the front of the tumor and then its pedicle is to be divided by rapid strokes of the amputating knife, the spermatic cords being seized to prevent retraction; if the genital organs are preserved, flaps must be formed, one in front to cover the penis, and two laterally to invest the testes; hemorrhage must be arrested, during the operation, by pressure with dry sponges.[1] The after-treatment is that of all large wounds of integument, the object being to secure prompt union.

---

[1] T. B. Curling. [2] Pruner. [3] Kaposi. [4] Esdaile.

Varicocele is due to a varicose state of the veins of the spermatic cord, resulting in an enlargement of its tissues, forming a pendulous mass, which becomes a source of inconvenience. The early treatment is support by means of a suspensory bag. If the scrotum becomes very large and troublesome excision must be performed; this operation is sometimes curative. To avoid hemorrhage the clamp should be used as follows: Draw the scrotum between the blades of a serrated clamp[2] (Fig. 755), until the requisite amount is inclosed; turn the screw *c*, and approximate the blades so as to firmly compress the inclosed tissues; with one sweep of the knife remove the redundant portion near the clamp; sutures should now be introduced thickly through the two flaps and firmly tied, when the clamp may be removed, or it may be retained partially loosened.

Fig. 755.



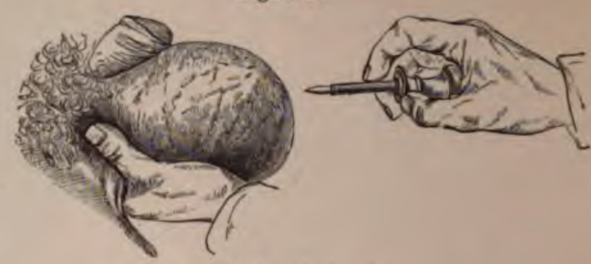
Henry's serrated clamp.

Cancer of the scrotum, epithelial,[1] is generally developed as a small pimple, or warty excrescence, which often remains for months or years without undergoing any change; there may be one wart, or two or three; after a time it becomes soft, excoriated, and red, and exudes a thin discharge, which dries as a scab; ulceration follows, characterized by an indurated base with elevated edges, and an irregularly excavated surface. There is no effectual remedy but the knife, and greater success attends removal than similar operations on other parts. The mass should be removed by two elliptical incisions.[3] If inguinal glands are involved, they may be successfully extirpated.

Hydrocele is an accumulation of fluid in the sac of the tunica vaginalis, and is caused by any condition which stimulates that membrane to over-secretion. It commences at the lower part of the scrotum and gradually extends upwards, and, when well marked, the tumor is tense, transparent, and fluctuating, has a smooth and uniform surface; the testicle is not defined, but the spermatic cord can be traced to the swelling;[1] if the hydrocele is old, the walls may be so thick that the transparency is lost. The methods of treatment more frequently adopted are as follows: 1. Tapping for temporary relief; grasp the tumor in the left hand (Fig. 756), the anterior surface being uncovered; avoiding veins, puncture directly, withdraw the trocar, and pass the canula into the cavity, inclined slightly upwards and backwards; care must be taken not to penetrate so deeply as to wound the testicle. 2. Injections often cure; the best are tr. iodine and carbolic acid. Of iodine use ʒj to ʒiij pure tincture, with plati-

[1] T. B. Curling. [2] M. H. Henry. [3] Sir J. Paget.

Fig. 756.



Tapping a hydrocele.

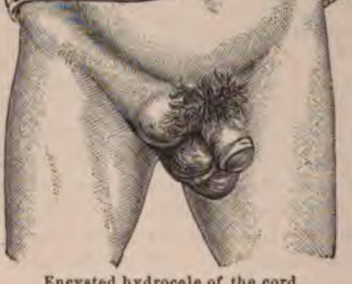
num canula, and rub the testicle to diffuse the fluid; leave the fluid all in; the inflammation will be quite severe, but curative. Of carbolic acid use 5 to 10 drops pure, or ʒss in ʒj glycerine and diffuse it by rubbing; the inflammation which follows renders the cure certain.[1] 3. Incisions through the sac, with antiseptic dressings, are very successful:[2] Shave the parts thoroughly and wash with bichloride; make an incision from the external ring to the base of the scrotum; wash out the sac with a three per cent. solution of carbolic acid; secure bleeding vessels with catgut ligatures; stitch the edges of the tunica vaginalis to the skin with the finest silk sutures; apply iodoform dressings. If the edges of the wound are so thick as to make it deep, insert a drainage-tube; lay a mass of gauze over the genitals, with an opening for the penis, so as to cover the groin and lower part of the abdomen, and bind it on with antiseptic gauze bandages; leave the dressings on three or four days, when the cavity will be obliterated by adhesion.

II. THE SPERMATIC CORD.

The constituents of the cord are the excretory duct, bloodvessels, lymphatics, nerves, and cremaster muscle; it extends from the internal abdominal ring downward to the back part of the testicle.[3]

Hæmatocele of the cord results from a rupture of a spermatic vein during violent and sudden exertion, or from contusion. It may be diffused or circumscribed. When diffused, it has been mistaken for hernia, but a careful study of the symptoms will determine the difference, or an exploratory incision may be made. The encysted variety is rare, and cannot certainly be diagnosed, except by puncture. The treatment should at first be cold applications; if the tumor does not disappear, but inflames, or is a source of annoyance, its contents should be removed, antiseptically, by incision.

Fig. 757.



Encysted hydrocele of the cord.

---

[1] R. J. Levis. [2] R. Volkman. [3] J. Leidy.

Hydrocele of the cord[1] (Fig. 757) is the collection of fluid in some part of the cord; the sac is thin, and is, in most instances, an unobliterated portion of the canal of the tunica vaginalis, which has become distended by accumulation of fluid in it; the tumor is usually oblong, transparent, and may exist as an independent cyst. The treatment is the application of tr. iodine, with pressure, which frequently induces absorption; if the fluid is encysted, it may be evacuated by puncture and the sac obliterated by an injection of tr. iodine.

III. THE TESTIS.

The gland consists of two parts, the epididymis and the body; the epididymis is the continuation of the spermatic cord, and is closely applied to the posterior part of the body; the body consists of the glandular structure, invested by a dense white membrane, the tunica albuginea.

Hæmatocele[1] consists of an effusion of blood either into the cavity of the tunica vaginalis, from a vessel ruptured by a blow, or into a hydrocele or cyst; when the enlargement immediately follows injury, and the parts are discolored, the diagnosis is easy; but when the affection is more chronic, and the ecchymosis has passed away and been forgotten, the diagnosis is often very difficult. Apply cold to arrest bleeding and promote absorption; if the accumulation remain, and create irritation or inconvenience, puncture antiseptically and evacuate the blood; if suppuration occur, open the cavity, cleanse it with carbolic acid solution, and apply dressings as for an open abscess.

Epididymitis is caused by injuries, or by irritation in the urethra, especially about the orifices of the seminal ducts. It commences with tenderness and swelling of the lower and posterior part of the epididymis; the swelling extends until the whole epididymis is involved, serum and lymph being infiltrated into the connective tissue; the pain is often very severe in the early stages, being dull, heavy, and sickening.[1] On examination, the line of division between the soft testicle in front and the hard inflamed epididymis behind, can be readily traced. The treatment should depend upon the severity of the disease. In the gonorrhœal form, all efforts to arrest the discharge must be abandoned. In general, direct the recumbent position, and support the parts in a suspender.

Double a handkerchief so as to form a triangle, the middle of the base, to which a piece of double tape has been sown, being applied to the perineum, and the extremities of the handkerchief carried forward and attached in front to a band round the waist, whilst the ends of the tape being secured to the band behind prevent the handkerchief slipping forwards.[2]

In mild cases it is often sufficient to secure rest, elevation of the organ with spirit lotions, or hot poultices, and saline cathartics. In acute cases, apply a tobacco poultice as follows: Mix a paper of any fine-cut tobacco, ℥j in ℥x of hot water; raise it to a boiling point while stirring it briskly, and add ground flaxseed, until the proper consistence of a poultice is obtained[1] In obstinate cases, apply six to twelve leeches in the course of the cord above the inflamed part.[2] Ice is sometimes useful when the inflammation is severe, but it must be so applied and maintained as to preserve a uniform low temperature of the parts. When the inflammation subsides there often remains considerable enlargement, which may be reduced by uniform strapping, which is a valuable remedy. There are many methods of strapping a testicle, and it requires much practice to operate well.

---

[1] G. M. Humphrey.

[2] T. B. Curling.

(1) The patient being placed in the recumbent position, with the testicle raised, is to remain there three or four minutes, in order to allow the vessels of the gland to become as empty as possible. The parts are to be shaved; and some adhesive plaster, or plaster spread on leather, must be cut into strips, about three-quarters of an inch in width, and eight or nine inches in length. The opposite testicle and side of the scrotum being drawn away from the diseased one, so as to render the integuments of the latter quite tense, the first strap is to be placed circularly (Fig. 758) around the cord, just above the testicle, as tightly as the patient can bear it; a strip of lint may be placed beneath the edge of the plaster to prevent its irritating the scrotum; the second strap is to be placed in an opposite direction, from behind forwards, at the side of the testicle, near the septum; the third strap is to be applied below the first, so as partly to overlap it; and the fourth in like manner, internal to the second, and so on until the straps meet, and the whole of the testicle is covered and evenly compressed. (2) Or, the patient standing; take the scrotum in the left hand, press the testicle firmly down to the bottom of the sac, and hold its neck with the thumb and index finger; wind a strip an inch or more wide around the neck of the tumor two or three times to fix the organ in its place; now apply a series of strips vertically (Fig. 759), until the tumor is completely covered; finish the dressing with several strips passed around the organ.

Fig. 758.

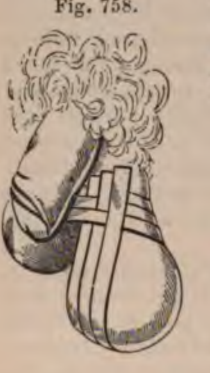
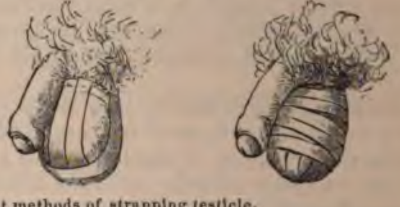


Fig. 759.



Different methods of strapping testicle.

Syphilitic orchitis, inflammation of the gland from syphilitic poison, occurs in the tertiary state of that disease.

The disease appears in two forms. The first is simply inflammatory; the mischief sets out from the interstitial structures in a hyperplastic growth of young connective tissue, followed by fibroid condensation; the white fibrous bands may be distinguished by the naked eye, conoidal in shape, determined by the lobular segmentation of the organ; finally, nothing is seen beyond a mass of white fibroid tissue, all trace of the old divisions of the gland having disappeared with the tubuli seminiferi. The formation of gummata is to be regarded as only a further specialization of the morbid process; several nodules of the size of a cherry-stone are usually scattered through the fibroid mass; the specific changes set out from a proliferation of the corpuscular elements of the connective tissue followed by a fatty degeneration.

---

[1] Van Buren and Keyes.

[2] T. B. Curling.

The enlargement of the testis usually takes place gradually and without pain, except perhaps along the cord, and is generally discovered by accident; it may be perfectly smooth, and hard as wood, but usually is nodular, and insensitive on pressure.[1] The treatment should be with mercury and iodide of potassium, as in the following formula: potas. iodid. ʒj; hydrarg. bichlor. gr. ss; syr. sarzæ; tr. cinch. co. āā ℥ij. M. Take one teaspoonful three times daily.[2]

If the surface is broken and a fungus appears, it should not be treated by excision but by strapping and nitrate of silver; removal of the enlarged organ should not be attempted until a thorough course of anti-syphilitic treatment has been tried faithfully, and with large doses of iodide of potassium.[1] The testis should at all times be properly supported by a suspensory bandage.

Tubercles of the testis consist of certain cheesy nodules of considerable bulk and more or less globular shape, commonly multiple for a time, but finally they coalesce to form a single mass, remarkable for its peculiar elasticity, which it retains until a central softening leads to an abscess; this tends to burst and give rise to the well-known fistula which is distinguished by extreme chronicity, and occasional discharge of sodden shreds of seminiferous tubuli through it. Suppuration rarely occurs in children.[3] The treatment should be largely hygienic, as exercise in the open air and nutritious food; quinine, iron, and cod-liver oil are the most useful remedies; the testis must always be supported. Castration is required to prevent general glandular infection if the disease involves the organ extensively.

Sarcoma in all its principal varieties finds a favorite seat in the testicle; the tumor almost always contains not only all the chief varieties of sarcoma, but all the histoid formations which are met with in the sarcomata as well; cartilage, mucous and connective tissue, striped and unstriped muscle, enter more or less into the composition of the sarcomata of this organ; these frequent combinations introduce an element of great variety into the structure of the sarcomata of the testicle, and this is rendered more manifold by the frequent occurrence of cysts in their interior. The growth is slow, usually painless, oval, and smooth. The treatment is removal of the gland.[4]

Cancer of the soft variety is not easily distinguished from soft sarcoma; it is the only form which primarily attacks the testicle. It develops rapidly, is uneven, with hard and soft spots, the pain is often severe, and the tumor may attain to an immense size. Early extirpation is the only remedy.

Castration[3] is an operation simple, easy of performance, and nearly free from danger. Shave the hair from the pubes and scrotum, and disinfect the surfaces; the patient being properly placed, and under ether, irrigation with bichloride solution should commence on the parts and continue during the operation; make an incision from about half an inch below the external ring along the front of the tumor to the bottom of the scrotum; divide the envelopes of the cord and testicle, the layers of the thickened fascia, and the cremaster muscles nearly as high as the ring; expose the spermatic cord, and detach it from the surrounding parts; if the division is to be made high up, pass a very stout double ligature through it, tie firmly each half, and sever the cord below; if the division is near the testis, grasp the cord firmly with the fingers, cut it below, and tie the arteries separately, first the spermatic artery, and next the artery of the duct; the gland is next to be removed, partly by tearing it from its connections; ligate all bleeding vessels; the wound should be closed by sutures, except at the lowest angle, where a drain-tube should be introduced. Iodoform dressings should be applied with a double spica bandage (Fig. 596).

---

[1] Van Buren and Keyes.

[2] V. Mott.

[3] T. B. Curling.

[4] T. Billroth.

CHAPTER LVI.

THE PROSTATE GLAND.

THIS body[1] is situated between the neck of the bladder and the triangular ligament, and surrounds the first portion of the urethra.

It is usually from one to one and a half inches in length and breadth, and about three-fourths of an inch in thickness; its apex adheres to the triangular ligament, and its notched base encircles the neck of the bladder; the lateral portions form the lateral lobes, and the isthmus which unites them beneath the neck of the bladder is called the middle lobe.

Injuries of the prostate usually occur during operations involving the bladder and urethra. They can only be treated by rest and cleanliness; if urinary extravasation occurs, or abscess forms, free incisions are necessary to prevent further accumulations.

Acute prostatis is usually due to injury or extension of urethritis. It is attended by a constant aching pain in the perineum, in the loins, and down the thighs; frequent and painful micturition; tenesmus; rectal examination easily determines the nature of the disease. The treatment should be saline cathartics, leeches to the perineum, diluent drinks, hot poultices, hot baths, opium, and belladonna suppositories. As urine is liable to be retained a soft rubber catheter, well oiled, should be carried into the bladder, and it is well to precede the operation by injecting warm sweet oil into the urethra. Abscess is one of the results of acute inflammation, and is ushered in by chills, increased dysuria, very painful defecation. The abscess ruptures more often into the urethra; but it may penetrate towards the perineum causing swelling and hardness, or it may make its way to the rectum. If it appear in the perineum, incision should be promptly, but care-

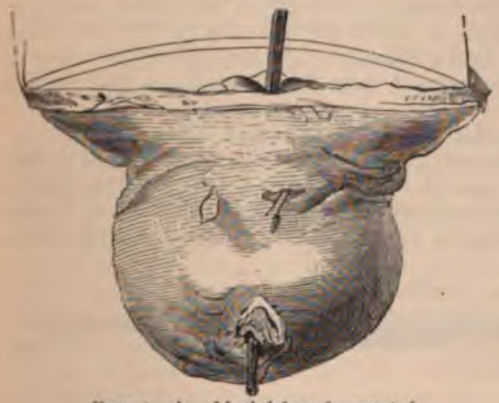
---

[1] J. Leidy.

fully, made down to it. If fluctuation is detected in the rectum, examination should be made with a single-blade speculum, the patient lying on his side, and the speculum pressing against the peritoneum; with a long needle the swelling must be explored, and if pus is detected, the abscess must be opened with a bistoury. The after-treatment is directed to cleansing the parts with warm-water enemata, carbolized, and regulation of the diet.

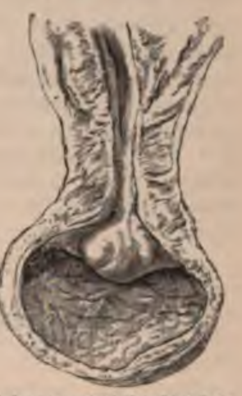
Hypertrophy of the prostate takes two forms; in the less common variety there is a uniform enlargement of the organ (Fig. 760) in all its dimensions and a marked increase in its density, due to the presence of an exceedingly tough, inelastic, whitish, fibrous tissue which permeates the entire gland; the muscular bundles are all in a state of overgrowth, while the gland-tubuli waste and disappear. In the more usual form there are discrete nodules in the substance of the gland, rounded in form, containing both glandular and muscular elements. The manifold varieties of external form presented by the hypertrophied prostate, the implication now of its right, now of its left lateral lobe, and then of its middle lobe, the immense variety of distortions and dislocations to which the prostatic part of the urethra may be subjected, are phenomena easily explained by the lack of uniformity in the distribution and rate of growth of the nodules. The first effect on the prostatic urethra is increase of its antero-posterior diameter, with diminution of its lateral or transverse diameter, the canal becoming a narrow passage, instead of one which, when distended, is of about equal diameter in every direction; the length of the prostatic urethra is also materially increased, and is often tortuous; the natural direction also deviates, namely, where the median portion is enlarged, the urethra suddenly rises, producing an angular curvature in place of a nearly straight line (Fig. 761); if there is

Fig. 760.



Hypertrophy of both lobes of prostate.[1]

Fig. 761.



Enlargement of the third lobe of the prostate, with dilatation and hypertrophy of the bladder.

---

[1] J. E. Erichsen.

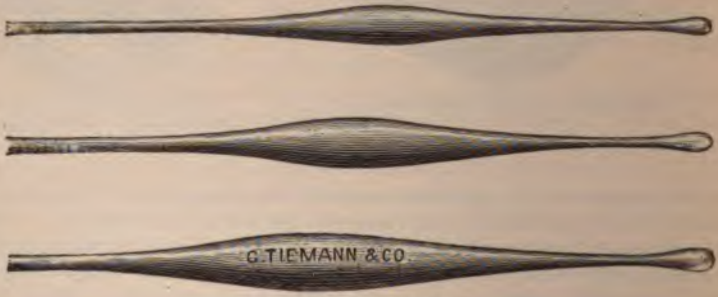
also enlargement of either lateral lobe, the lateral direction of the canal is also changed, the convexity being towards the large lateral lobe.

The most important result of enlargement is obstruction to the flow of urine, but the symptoms not unfrequently exist long before the real cause is suspected; there is more frequent desire to pass water, but the force is diminished; a disagreeable sense of weight and fulness is experienced about the perineum; cystitis follows; then pyelitis, and the patient is finally worn out with suffering. But the test chiefly depended upon is digital examination by the rectum, as follows:[1] Place the patient on his back on a couch, with his knees drawn up and separated a little; standing on his right side, introduce the index-finger of the left hand slowly through the sphincter, and when two phalanges are free in the rectum, define the size, form, and consistence of the prostate; then, with the right hand, so manage the catheter introduced through the urethra as to determine the thickness of tissues, and the direction of the canal. Now withdraw the finger, and explore with the ordinary catheter; if it pass as usual, and water flows to the depth of six to eight inches, the evidence is against hypertrophy; but if the instrument passes nine or ten inches before urine escapes, and the handle is unusually depressed, there will be little doubt of enlargement; a prostatic catheter should now be used, which is two to four inches longer, with a larger curve, and the direction which it takes, the depth at which water begins to flow, and other facts noted. One of the best evidences of hypertrophy is the flow of urine through the catheter, passed immediately after the patient has evacuated the bladder.[2]

The treatment of this affection is palliative and radical:—

1. The palliative treatment aims to remove every source of irritation, as gleet, excessive venery, intemperance in stimulating drinks, acid urine. If there are indications of the development of hypertrophy, the attempt should be made to keep the passage well open; this can be effected to an extent that, in spite of enlargement, the obstruction will be so slight as never to give any inconvenience. The following course of treatment is recommended:[3] On the recognition of symptoms indicating that enlargement of the prostate has com-

Fig. 762.



Reginald Harrison's dilators.

---

[1] Sir H. Thompson. [2] R. F. Weir. [3] R. Harrison.

menced, at once urge the regular and persistent employment of the prostatic bougie; for the most effectual carrying out of this treatment, instruct the patient as early as practicable in the introduction of the bougie, and, when the size of the instrument is determined, require him to use it daily, or at least thrice a week, on going to bed.

In the employment of instruments for this purpose it is of importance that a kind should be used which is efficient, and at the same time incapable of doing harm to the parts when placed in the hands of a non-professional person of average intelligence; the instrument which best answers the purpose is the bougie olivaire (Fig. 762).

The olive-shaped dilators exercise as much pressure as can be desired on the obstructing portion of the prostate, whilst, by reason of the small size of the stem, no tension is thrown on the most sensitive portion of the urethra—namely, the orifice. These prostatic dilators are made from two to four inches longer in the stem than ordinary urethral bougies, in order that the olive portion may be fairly passed into the bladder; in this way pressure is exerted on the prostate, as the expanded part passes into the bladder, and again as it is withdrawn; it is very important that the instrument should be used in this way, as the dilatation exercised by the bulb, on the withdrawal of the bougie, corresponds with that of the urine as it is expelled from the bladder. The constant use of the dilator has the effect of maintaining an open urethra (Fig. 763).

Fig. 763.

Passage maintained by bougie.[1]

The patient should place himself in the recumbent position, with the buttocks slightly raised, and then, having lubricated the bougie freely with vaseline, and made it pliable by drawing it a few times through the hand, he should slowly introduce it until the expanded portion is fairly within the bladder; he then gently withdraws it; the prostate is thus twice acted upon by the expanded portion of the dilator. At first the instrument may be passed once in forty-eight hours, subsequently twice, and, where the prostate has already become large, it may be used night and morning with most satisfactory results. If the treatment is commenced sufficiently early, though the prostate may be hypertrophied, obstruction to micturition is effectually prevented. When the prostate has already become enlarged, and there is also difficulty in urinating, this treatment will be found equally efficacious. In either case it is necessary to continue this treatment long after all indications of obstruction have ceased; when, however, the patient has acquired the habit of self-catheterism, he is loth to forego it, as any slight inconvenience the operation may occasion is not to be put against the obstruction to micturition that usually terminates all cases where an enlarged prostate is left untreated when mechanical treatment becomes a necessity.[1]

Cases are occasionally met with where patients have an apparently unnatural degree of intoleration of instrumental interference with the urethra, even of the gentlest kind; many of them would be largely benefited by such treatment, but are debarred from the advantages by what almost amounts to an idiosyncrasy; this extreme sensitiveness of the urethra has been found to be due to the presence of uric acid crystals in unnatural quantities in the urine, and by preliminary treatment, having for its object the correction of the urine, those previously intolerant have been capable of undergoing, with the fullest advanage, the instrumental treatment that was necessary.[1]

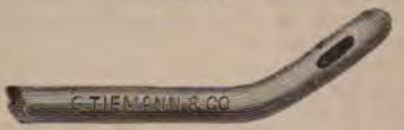
---

[1] R. Harrison.

When the prostate is already large, and the bladder is never completely emptied, use a catheter, similarly shaped to the prostatic dilator, in order that all the urine may be removed at the same time that dilatation is practised.

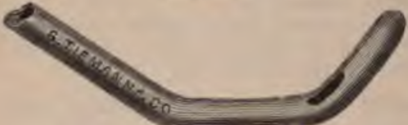
If the hypertrophy increases great difficulty is often experienced in passing a catheter through the prostatic urethra, owing to its irregularities, and many modifications have been made to meet these peculiarities. Of these the most useful are the single (Fig 764),[2] and double elbow catheters (Fig. 765),[2] the ends of which keep closely applied to the roof of the urethra. In some cases the canal is more readily traversed by the vertebrated catheter.[3] In very tortuous passages a prostatic guide,[4] with spiral shaft (Fig. 766), will follow the devious route.

Fig. 764.



Single elbow catheter.

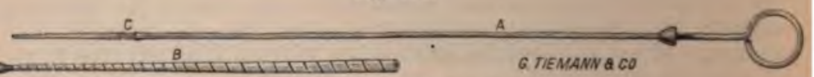
Fig. 765.



Double elbow catheter.

The prostatic guide consists of a slight steel rod, A (Fig. 766), eight inches in length, upon which is screwed a spiral ribbon, B, five inches in length. The union is strengthened by the projection of the end of the rod into the spiral, for half an inch beyond the screw, C. This spiral ribbon is so flexible that it can easily be made to take the curve of the urethra, or any irregularity in its course which may present. Its small size may make it capable of being easily introduced into a soft rubber catheter, and by means of it the catheter may be carried down and along the urethra to and into the bladder, following any deviation in the course of the canal which may be present from prostatic enlargement or other causes.

Fig. 766.



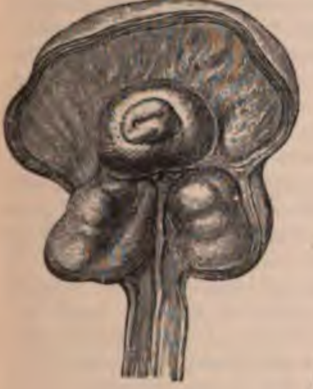
Prostatic guide with spiral shaft.

At length the disease may progress so that the use of the catheter becomes extremely difficult, and is attended with great suffering. The greatest obstacle is generally the enlarged middle portion of the prostate which directly blocks the passage (Fig. 767). Whatever form of catheter is used in the more aggravated cases, the growth presents an almost complete bar to the progress of the instrument (Fig. 768). In this class of cases two methods of relief have been proposed, viz., prostatotomy and prostatectomy.

---

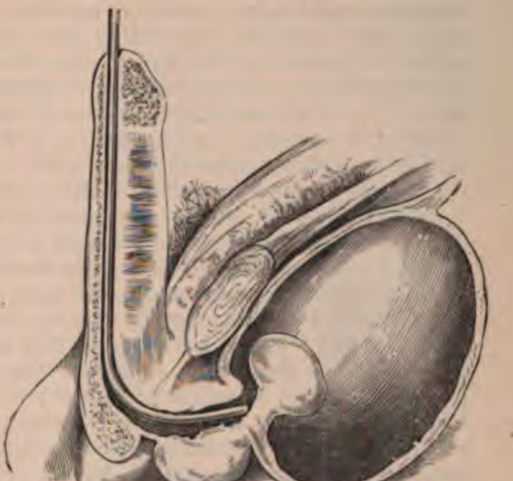
[1] R. Harrison. [2] A. Mercier. [3] T. R. Squires. [4] F. N. Otis.

Fig. 767.



Bladder laid open, showing enlargement of urethral portion.[1]

Fig. 768.



Enlarged middle lobe of prostate, arresting progress of catheter.[1]

Prostatotomy,[2] incision of the prostate, may be either external or internal:—

1. External prostatotomy[3] consists in opening the membranous urethra in the middle line, and dividing the obstructing median portion of the prostate, partly with a straight probe-pointed knife, and partly by divulsion with the finger or a large-sized bougie, until the access to the bladder is felt to be free; a double drainage-tube is then inserted, and retained for from six to twelve weeks, through which the section of the median lobe or bar-like ridge is made permanent, the indication for removal of the tube being the easy introduction of a catheter along the natural route, and the passage of the urine along its side. A bougie is inserted regularly until the external wound has closed, and its occasional use is continued as a precautionary measure.

In the case related as an illustration of the happy result of this procedure, the patient was out of his bed in ten days, and the drainage apparatus was used for eight weeks; there was no further trouble in micturating or in passing the largest sized catheter; the bladder regained natural power of expulsion; there was no residuary urine, and he could retain the fluid for four hours.

2. Internal prostatotomy consists in incising the obstructing growth, as in the division of a stricture and the passage of a large-sized bougie. The parts are dilated by the frequent use of a large bougie.

Prostatectomy,[2] excision of the enlarged portion of the prostate, may be either external or internal:—

1. The external operation consists in making the usual perineal incision, opening the urethra, and removing such portion of the prostate as obstructs the passage.

---

[1] J. E. Erichsen. [2] J. W. S. Gouley. [3] R. Harrison.

2. The internal operation is performed with a prostatectome which resembles an ordinary modern lithotrite, having a male and female blade, the one sliding into the other; the male blade is hollow, its sides vertical, and its superior portion a little rounded; it is welded to a tubular shaft, in the centre of which is a long needle, worked by a button at the proximal extremity of the handle; the object of this needle is to transfix the prostatic valvule or tumor, and hold it in position from the moment it is seized till it is cut and extracted, the cavities in the two blades rendering extraction certain. To seize and punch out a piece of the valvule the instrument is introduced locked, the beak is reversed as soon as it has entered the bladder, and the screw turned from right to left, so as to open the blades or jaws, when the male blade will pass over the valvule and drop in front of it into the prostatic sinus; the instrument still locked is moved to and fro, that the operator may know that it is in its proper position, then the needle is thrust through the valvule until its point has entered a shallow pit in the posterior wall within the female blade; the screw is now turned from right to left until there is slight resistance; a few slow turns of the screw which drives the male blade home will complete the section, with a peculiar crunching sensation; the instrument is pushed into the bladder and then slowly withdrawn holding the segment in its closed jaws. The after-treatment consists in the introduction of an instrument to make dilatation and depression of the urethro-vesical orifice once every five days to retard the process of cicatrization.

CHAPTER LVII.

THE PENIS.

The penis is composed principally of an erectile tissue arranged in masses which occupy three long and nearly cylindrical compartments, namely, two, the corpora cavernosa, placed side by side, which form the principal part of the organ, and the corpus spongiosum, which surrounds the canal of the urethra; it is attached to the pubic arch by its root, and in front ends in the glans which is continuous with the spongy body; the integument of the penis is continued from that of the pubes and scrotum, and forms a simple investment as far as the neck of the glans, where it is doubled up in a loose cylindrical fold constituting the prepuce.[1]

Injuries of the penis occur in many forms. The organ may be fractured by being forcibly bent when erect;[2] the treatment is cold. Contusions rarely require other measures than such as prevent inflammation. Wounds are to be treated as other wounds, care being taken to prevent urinary infiltration and curvatures in cicatrization.

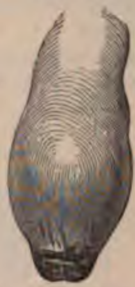
---

[1] Quain's Anatomy.

[2] V. Mott.

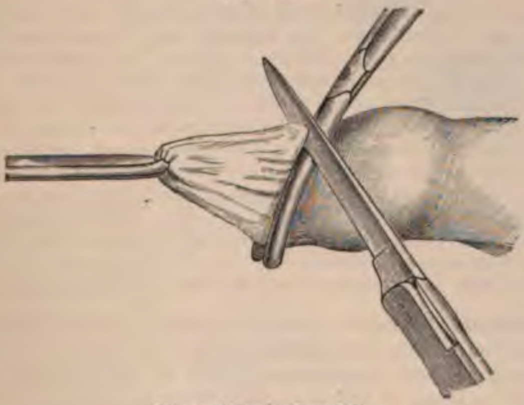
Phimosis is such a contraction of the prepuce that the glans cannot be uncovered; in the normal condition of the infant the prepuce is adherent to the glans, but later these adhesions are broken down and the prepuce becomes free. If, however, there is inflammation excited by irritants, as accumulations of filth under the prepuce, these adhesions may become firm; or, the orifice may become inflamed and so dense that it will not yield, even to allow the free passage of urine. The affection may be a source of great discomfort in children, resulting in spasms of the muscles of different parts of the body,[1] and in adults of collections of filth and foul matters. In performing this operation it is important to seize the orifice of the prepuce for the purpose of making suitable traction on the mucous membrane, which is but slightly elastic compared with the skin. First, insert a well-oiled probe under the prepuce, and sweep the surface of the glans to break up adhesions; seize the prepuce with sharp-toothed forceps, and draw it forward until it is put well upon the stretch (Fig. 770); grasp the prepuce firmly just in front of the glans with forceps, and with the bistoury cut away the portion anterior to the clamp; the prepuce readily retracts; now with blunt scissors slit up the mucous membrane on the dorsum, trim its edges, and unite the mucous and skin flaps by a number of fine sutures; if the prepuce is not free, all tightness must be relieved by an incision on the dorsum, or, in infants, by tearing the tissues; the cut mucous membrane must be attached to the skin by numerous fine sutures beginning at the raphé; rest and water dressings only are required in the after-treatment.[2] In slight cases it may be sufficient to slit up

Fig. 769.



Irritated congenital phimosis.

Fig. 770.



Circumcision in the adult.

---

[1] L. A. Sayre.

[2] Van Buren and Keyes.

the prepuce on the dorsum, and attach the edges as before. If there is a contracted prepuce after the excision,[1] slit up the skin three to six lines on the dorsum of the penis (Fig. 771), trim the corners round, 5, 4, 6 (Fig. 772), incise the mucous membrane 2, 1, 3 (Fig. 772), adjust the point 1 to 4, 2 to 5, and 3 to 6, with sutures, and the rest of the circumference by a sufficient number to hold them in position.

An ingenious instrument for performing circumcision has been devised (Fig. 773).[2]

Fig. 771.

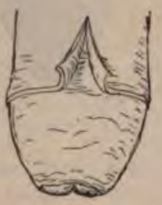
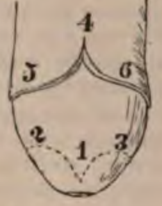
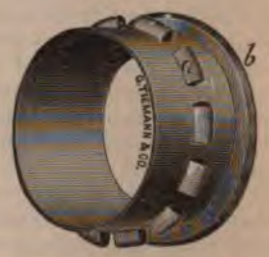


Fig. 772.



Preparation of flaps.

Fig. 773.



Ross's circumcision ring.

It is a light, flat ring of hard rubber, with two ridges upon its outer surface, the posterior one, *b*, continuous, the anterior one, *a*, interrupted or notched. It is to encircle the glans penis under the prepuce, the latter being drawn forward over the instrument and compressed against it, in the groove between the two ridges, by a small cord wound round its integumentary surface. The foreskin is then to be severed in front of the instrument, the notches in the anterior ridge are to facilitate introduction of the sutures, but are not necessary. Apply cocaine freely to the cut edges and introduce plenty of fine sutures with a small curved needle entered at the bottom of the notch upon the mucous surface and brought out on the surface of the skin. The introduction of each suture is considerably expedited by picking up the edge of the mucous membrane with a slender pair of toothed-forceps. If the prepuce do not admit the ring slit up the skin on the dorsum until the ring will pass within it.

Paraphimosis[3] occurs when the prepuce is withdrawn behind the glans and cannot be brought forward; the prepuce forms a constricting band around the corona, which is followed by swelling of the glans and œdema of the prepuce. The treatment is prompt reduction. If the swelling is slight, and without strangulation, reduction may be effected by the methods given below, or by strips of rubber plaster applied longitudinally from the middle of the penis on one side over the apex of the glans to the middle of the penis opposite, the meatus being left uncovered, until the organ is covered. If there is dangerous strangulation shown by the dark color of the glans, and great œdema of the prepuce, reduction is more difficult, but may be aided by employing cold, and puncture of œdematous parts. Reduction is effected as follows: Give an anæsthetic; seize the penis behind the strictured prepuce, between the index and middle fingers of both hands, placed on either side (Fig. 774), make pressure with the thumbs on both sides of the glans, in such direction as to compress the glans laterally, rather than from before backward, and at the same time pull the strictured portion of the prepuce forward; the manipulation is designed to reduce the glans by compression, and pull the stricture over the glans, and not to push the glans through the stricture.

---

[1] E. L. Keyes. [2] J. N. Ross. [3] Van Buren and Keyes.

Or, the penis may be encircled with one hand (Fig. 775), while compression is made with the thumb and finger as before. Or, place the index and middle finger of the right hand longitudinally along the lower surface of the penis, and the pulp of the thumb on the dorsum of the glans and the œdematous ridge in front of the point of stricture; by firm pressure crowding down the swollen mucous membrane of the prepuce, endeavor to insinuate the end of the thumb-nail under the stricture; succeeding in this, grasp the penis and the two fingers of the right hand beneath, in a circular manner, with the left hand, and draw the strictured point up over the thumb-nail, and by simultaneous traction of both hands replace the prepuce.[1] If a prolonged and careful attempt at reduction fails, the strictured point must be divided as follows: Introduce a bistoury knife flatwise along the sheath of the penis, subcutaneously, under the stricture, and cut outward until all tension is removed (Fig. 776); or, a simple incision may

Fig. 774.

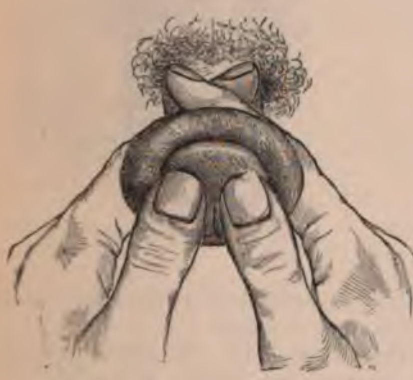
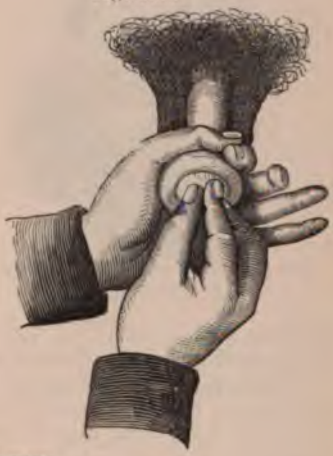
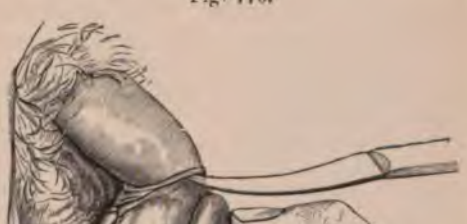


Fig. 775.



Reduction of paraphimosis.

Fig. 776.



Mode of dividing prepuce in paraphimosis.

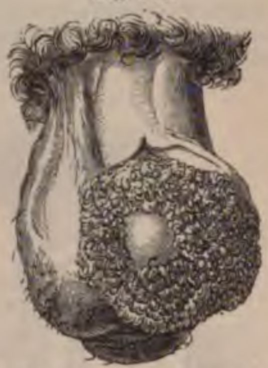
---

[1] A. Mercier.

be made down to the sheath of the penis. The after-treatment consists of cleanliness and syringing the preputial cavity with carbolized water.

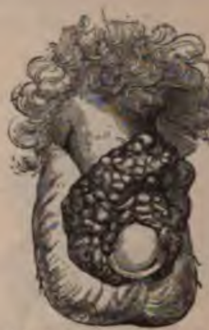
Warts may grow to a great size on the penis (Fig. 777). They are distinguished from epitheliomata by their luxuriant growth, and their rapid spread along the prepuce; they are due to venereal discharges, and local filth. They should be removed with scissors, and the wound should be dressed with iodoform gauze.

Fig. 777.



Warts on the glans and inner surface of prepuce, which is slit up.

Fig. 778.



Epithelioma of the penis.

Cancer, of the epithelial variety (Fig. 778), frequently affects the penis; it may occur on the prepuce, but usually it appears on the glans as a firm, warty elevation, having a broad base; it slowly increases, without pain, at first covered with a more or less thick cuticular crust, which leaves a bleeding surface when removed; in its progress it destroys the glans, opens the urethra, involves the prepuce, finally affects the glands of the groin, and proves fatal, by irritation, and discharges from progressively spreading ulceration.[1] The treatment is extirpation. If the prepuce alone is affected, circumcision must be performed. If the glans is slightly affected, the diseased part may sometimes be excised without injuring the urethra. In general, amputation through the anterior part of the penis is performed, as follows: Inclose the organ at its root in a clamp like that used for hemorrhoids, or apply a tape to prevent hemorrhage; divide the organ at a stroke, the skin being slightly retracted, owing to its tendency to excessive retraction; ligate all the vessels, then slit the urethra above slightly and below to the extent of half to two-thirds of an inch to render the new opening patulous after cicatrization; now carefully connect the urethral margin to that of the skin by many fine sutures, commencing at the lower angles. Apply iodoform dressings.

If the disease involve the penis at a higher point, it may be necessary to extirpate the organ altogether, as follows:[2] The patient having been etherized, make a curvilinear incision on either side of the root of the penis, beginning in the median line, at about one inch and a half above the level of the pubes, and ending a little below the peno-scrotal junction; this elliptical wound exposes the cavernous bodies, which may be transfixed by a large knitting-needle, the ends of which rest on either groin and serve to prevent retraction of the stump; pass a smaller knitting-needle across and through the urethra on the same plane as the first needle, and with serrated scissors[1] sever the penis at a point about one-eighth of an inch anteriorly to the needles; four or five vessels require the ligature besides those of the subcutaneous tissue, which are secured in the pubic and scrotal portions of the wound; the mouth of the urethra is easily found on account of the needle, and a grooved staff is introduced through it into the bladder; plunge a scalpel into the centre of the perineum and into the groove of the staff, and divide all the tissues, including the skin, at one sweep of the knife from behind forward and from below upward; the urethral cut is about an inch and a quarter in length, including half of the bulb, and the cutaneous wound three inches; detach the urethra from the cavernous bodies, slit it longitudinally, and stitch its free extremity to the upper commissure of the perineal wound and its edges to the skin.

---

[1] G. M. Humphrey.

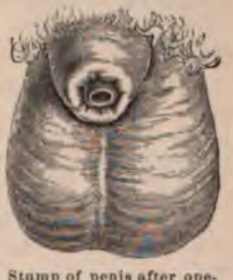
[2] J. W. S. Gouley.

A more effective operation is that in which the corpora cavernosa are entirely detached from the rami of the pelvic bones. The steps of the operation may be the same as those given, but it is completed by detaching the crura of the penis from their bony attachments with a periosteal knife, as follows:—[2]

First divide the scrotum into its two halves along the line of the raphè from the root of the penis to the perineum down to the corpus spongiosum, in which a full-sized catheter has been placed; now push the catheter as far as the triangular ligament; pull the corpus spongiosum forwards, and cautiously separate it from the body of the penis; draw out the catheter, cut away the corpus spongiosum, and detach its deeper portion as far as the triangular ligament. Next dissect round the upper part of the root of the penis, cut through the suspensory ligament, and detach the penis wholly except at the crura. Attack in succession the two crura with a periosteum elevator and the knife; from their depth considerable trouble may be experienced, and the hemorrhage may be difficult to arrest, but the deep arteries may be secured with patience; slit up the end of the corpus spongiosum for about half an inch, and stitch the edges of this cut to the back part of the skin wound immediately behind the scrotum; bring together the two halves of the scrotum, and stitch them; place a drainage-tube in the deep part, and bring the ends out above and below.

Amputation of the penis by galvano-cautery[3] has the advantage that there is no hemorrhage accompanying the operation. Introduce a gum-elastic catheter into the urethra, and pass the platinum wire with a needle between the spongy body and the urethra, and then around the penis, and make it tight with the écraseur screw. Now connect with the battery, and slowly screw the wire home; the spongy body and urethra should be divided half an inch nearer the glans. It is well to complete the operation by slitting the urethra for about half an inch; turn its two edges outward, and fasten them to the skin with sutures. When the knife is used, the spongy body may be separated from the cavernous bodies by the introduction of a narrow bistoury between them, the latter are then divided at a higher point than the former, which tends to leave the urethra slightly projecting.

Fig. 779.



Stump of penis after operation.

---

[1] Richardson's.

[2] P. Gould.

[3] T. Bryant.

THE FEMALE ORGANS.

CHAPTER LVIII.

THE UTERINE APPENDAGES.

The uterine appendages consist of the ovaries, the Fallopian tubes, and the parovarium. The ovaries and Fallopian tubes are intimately associated in function; the parovarium is an embryonic structure.

I. THE OVARIES.

The ovaries correspond to the testicles of the male; they are somewhat flattened and oval, and are placed on each side of the uterus, at the back of the broad ligament, and are enveloped in its posterior membranous layer; each ovary is free on its two sides, and along its posterior border, which has a convex outline, but is attached by its anterior border.[1]

Inflammation of the ovary may become a powerful disturbing element in the physical constitution of woman; in some cases the ovarian pain and exacerbation of sufferings at the menstrual epoch are almost unbearable, in others it causes such violent disturbance of the vascular and nervous systems that life is jeoparded; occasionally it terminates in epilepsy or insanity, and ultimately in death.[2] In these extreme cases extirpation of the ovaries is now advised. The object sought is the artificial production of the menopause, or the cessation of menstruation.[3] The special conditions justifying the operation have been formulated by the highest authority in this department of surgery.[2]

1. In cases of amenorrhœa where there is no uterus, or only the rudiments of one, or where there is an incurable atresia uteri, and the menstrual molimen produces such violent disturbance of the whole system as to destroy health and endanger life, the removal of the ovaries is the only means of permanent relief. 2. In cases of prolonged physical and mental suffering attended with great nervous and vascular excitement produced by perturbed menstrual molimen, whether menstruation be absent, scanty, or otherwise, this operation is justifiable after all the usual remedies fail to relieve. 3. In cases of incipient insanity and of epilepsy depending upon ovarian and uterine disease this operation is justifiable after all other remedies have failed to cure. 4. In cases of fibroid tumors of the uterus attended with incurable hemorrhages that endanger life, when the tumors cannot be safely enucleated and removed, this operation may be resorted to with the hope of arresting the bleeding and the prospect of diminishing the tumors. 5. In cases of chronic pelvic cellulitis and of recur-

---

[1] Quain's Anatomy.

[2] J. M. Sims.

[3] R. Battey.

rent hæmatocele, when the attacks are traceable to the disturbing influences of the menstrual molimen, we may have recourse to this operation as a *dernier ressort*. The conditions requiring extirpation are thus given by one of large experience:[1] (*a*) pain; (*b*) intractable hemorrhage; (*c*) reflex symptoms.

Oöphorectomy, excision of the ovary, may be performed through the vagina, or through the abdominal walls. The operation through the vagina is limited to the removal of the ovary of small size, but is rarely preferred, even in cases to which it is best adapted, to the abdominal method.

The operation is generally very difficult, for it is quite exceptional not to find the tubes and ovaries densely adherent to the viscera and to the pelvic wall; in some operations the difficulty in overcoming these adhesions has transcended anything seen in the removal of cystic tumors of the ovary; the hemorrhage has sometimes been alarming during the operation, but it has been controlled by sponge packing; in three cases the diseased organs were removed only at a second attempt, and in one only at the third operation; all the patients recovered.[1]

1. Vaginal oöphorectomy[2] is now rarely performed, and is only adapted to cases of non-adherent ovaries which are quite the exception. It is as follows:[2] The patient, having been fully etherized, must be placed upon the table in the prone posture;[3] now retract the perineum by a speculum; grasp the cervix uteri with a volsella, and draw the uterus firmly downwards; make an incision through the walls of the vaginal cul-de-sac in the line of the fornix vaginæ; control the slight hemorrhage by cold sponges; grasp the peritoneum, nick and open it to the length of the original incision; pass the forefinger into the cul-de-sac, and examine the ligaments and Fallopian tubes, and determine the position of the ovaries; draw one as closely as possible to the incision, grasp it with the forceps, draw it through the opening into the vagina, pass a stout ligature around the pedicle, apply the chain of the écraseur and slowly sever the attachments; pursue the same method with the other ovary; cleanse the vagina, and secure quiet and rest.

2. Abdominal oöphorectomy is adapted to all cases requiring extirpation of the ovaries. The details are chiefly those of abdominal ovariotomy.

Cystic tumors of the ovary may assume many forms; they may be large and small, simple and compound, and may have watery, colloid, fatty, sanguinolent, or mixed contents.

Of the various ovarian cysts, the more important are the colloid, characterized by thick, viscid, frequently yellow or brownish gelatinous contents; they are always multiple at the outset, multilocular cysts, and are usually present in large numbers; in cases of long standing it often happens that one or several cysts are much larger than the rest, and finally there may be but one present, unilocular cyst, which is formed by the union of many smaller ones; as the manner of growth of these cysts has a great resemblance to that of the normal Graafian follicles, they have been called adenomata. By a conversion of the colloid contents into a more fluid substance, and by a constant secretion of liquid from the walls, the epithelial cells of which often perish, what is known as multilocular ovarian dropsy originates. Polypoid growths are often seen on the inner surface of these cysts, and extend into their interior; the cysts may undergo secondary changes by the admixture of blood with their contents, which gives them a brown color. Suppuration may take place from the wall, and the contents may become ichorous, usually in consequence of operative interference. In the case of large cysts, adhesions to the abdominal walls, intestines, etc., are almost constant. Besides the pure cystomata there are a large number of cystic tumors of different natures, for most ovarian tumors are prone to become cystic; thus there is a cysto-fibroma, cysto-carcinoma.

---

[1] L. Tait. [2] R. Battey. [3] J. M. Sims.

Cysts of the ovary are diagnosed from solid tumors by fluctuation; from ascites by the limited extent of the wave-impulse; from tumors of the uterus by their location, exploration of the cavity of the uterus by sounds, examination by the hand in the rectum, tapping or testing the fluid. The treatment is tapping, or extirpation of the ovary, performed as follows:—

1. **Tapping ovarian cysts** was formerly the usual practice. At the present time it has properly fallen into almost complete disuse owing to the great success of abdominal incision, both from exploration, and for the extirpation of the cyst. It is, however, occasionally resorted to by some practitioners, and there may be conditions which forbid an attempt at extirpation, where it may still be required. It may be performed by the vagina, or through the abdominal walls.

Tapping was formerly much resorted to both to relieve distension, and to aid in diagnosis. It is now discarded by the best operators for either purpose. It serves in no way to clear up the nature of a doubtful tumor, nor does it reveal what the intimate relations of that tumor may be; it has its own special risks, and our more recent experience shows that these risks are greater than, or at least as great as, those of a simple exploratory incision; by means of the incision, which need not as a rule be more than an inch and a half or two inches long, we can ascertain absolutely the nature of the tumor and very many of its relations, and we may generally obtain information concerning it altogether beyond the reach of tapping.[1]

(*a*) Tapping the vagina is more liable to be followed by the entrance of air into the cyst, suppuration, and fever. It is most useful when the cyst is found fixed in the pelvis, as it may be followed by drainage and antiseptic injections.

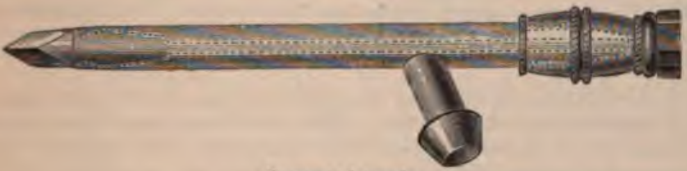
Place the patient in the lithotomy position, the bladder and rectum having been evacuated; introduce the index and the second finger into the vagina until they rest upon the most prominent part of the tumor; carry a canula ten inches long, with the trocar slightly withdrawn, along the finger, and plunge the trocar into the cyst, after the fluid has escaped, secure perfect quiet and guard against inflammation.

(*b*) When the abdominal wall is selected, the only danger is wound of a bloodvessel, and the entrance of air into the cavity of the cyst; the former accident is so rare as to require no consideration; the latter may be prevented by antiseptic measures, or the use of a proper trocar and canula (Fig. 780). The trocar is withdrawn after the puncture; the canula being within the cyst the fluid escapes through the rubber tube attached to the button on the side; the extreme end of the tube is immersed in a tub of water. The preparation of the patient and the details of the operation are the same as in paracentesis abdominis. It is important to observe the following rules:

---

[1] L. Tait.

Fig. 780.



Trocar and canula

(1) Never tap while the patient sits, but always as she lies upon the side or back; (2) cut the skin with a lancet, and employ a trocar and canula with tube immersed in water to prevent the entrance of air; (3) if the fluid withdrawn is viscid, always wash out the cavity of the sac with warm carbolized water; (4) should there be oozing of blood, pass a harelip pin deeply through the lips of the wound and affix the figure-of-eight ligature; (5) keep the patient recumbent and very quiet for two or three days.

2. **Ovariotomy,** extirpation of the ovary when affected by cystic disease, is now an operation of common occurrence, and when performed by skilled hands, is one of the most successful surgical procedures. As in other special fields of operative surgery the greatest success is in the practice of those who devote themselves to this and kindred operations, and hence have large experience.

It is maintained by competent authority,[1] that no surgeon engaged in constant attendance upon the promiscuous cases admitted to a general hospital should perform such an operation as ovariotomy, and as mere fool hardiness on the part of any one to perform it to whom it will probably never occur again to engage with such a case, or whose experience is likely to be limited to two or three such cases in a lifetime; it is operation beyond all others requiring that readiness of adaptation for emergencies which wide experience alone can give; its complications are far more varied and tax more heavily the courage and presence of mind of the operator than those of any other operation in surgery.

Two methods of operating have been practised, viz., the vaginal and abdominal.

(*a*) Vaginal ovariotomy has been practised when the cystic tumor was small and lying in the pouch between the uterus and rectum. It has proved a very successful procedure. The details of an operation have been given as follows:—[2]

The patient was placed in the semi-prone position. With a vaginal single-blade speculum the perineum and posterior vaginal wall was lifted, the fornix vaginæ was then caught midway between the cervix and rectum with a tenaculum, and drawn well down; with long handled scissors, one limb of which was placed against the rectum and the other against the cervix, the peritoneum was cut into at one stroke. The patient's position was now changed to the dorsal decubitus, with the finger passed through the vaginal incision the tumor was reached and a tenaculum fastened in its wall; with a small trocar the cysts were punctured, and then by traction the cyst was drawn into the vagina. The patient was again changed to the left side, the speculum introduced, and a needle armed with a strong double silk ligature passed through the pedicle at its point of exit from the vaginal roof; each half was tied, and the ligature and cyst cut off. The cul-de-sac was then sponged, the pedicle returned into the abdominal cavity, and the wound closed with a single silver suture. The operation occupied thirty-five minutes, and presented no difficulties other than those slight ones incidental to ligature of a pedicle at some distance up the vagina.

---

[1] L. Tait.

[2] T. G. Thomas.

(*b*) Abdominal ovariotomy is preferred in all ordinary cases of cystic degeneration of the ovary. The strictest antiseptic precautions should be taken in all stages of this operation. The general details of the operation are the same as those given for laparotomy (pages 467, 8, 9); the special features are summarized from the description of the operation as given by one of the most successful ovariotomists of the present time, who, however, never employs antiseptics.[1]

Operators generally observe the strictest antiseptic precautions in the details of this operation, and it is undoubtedly true that the great success of the operation at the present time compared with former years is due, if not largely to the antiseptic agents employed, at least to the infinitely greater attention paid to cleanliness, and to the careful and painstaking management of every stage of the proceeding. It is apparent that the remarkable results of this operation in the hands of those who discard antiseptic agents as germicides, is due to methods which conserve the forces of the patient, and practically render wounds aseptic.

The patient requires a little preparation for the change that is about to be made in her alvine actions; her food should be limited to soup and a little bread for forty-eight hours before the operation, and on the morning of the day previous she should have a small dose of castor oil. The room in which the operation is to be performed should be fairly large, and so arranged that ventilation may be possible from window or door to the fireplace without the current crossing the bed of the patient: there should be no unnecessary furniture, and as little upholstery work as possible. The patient is to be placed on a firm, narrow table with her feet directed against the window; the arms and legs are secured by bands to the table so that only one assistant is required, with one to give the anæsthetic and one nurse to look after the sponges. The instruments to be provided are as follows: a perfectly sharp scalpel, twelve catch-forceps, four handled needles, threaded with two thicknesses of silk, two pairs of cyst forceps, a pair of large screw bull-dog forceps, a clamp, a pair of scissors, a number of pieces of fine silk about a foot long for ligatures, a number of pieces somewhat thicker, eighteen inches long, for sutures, Paquelin's thermo-cautery, an aspirator, two sizes of trocar, twelve good sponges.

The catch-forceps are very valuable aids, for a bleeding point may be seized and held until the operator chooses to apply a ligature; frequently its grasp is sufficient to close the artery permanently; more than twelve are rarely required, and this number should be placed on a tray where they can always be seen and counted, and thus the danger of inclosing them in the cavity prevented. The handled needles, armed with silk, must be well made and well tempered, so that they will neither break nor bend: they must have broad-cutting points, and must not make big holes; the eyes must be perfectly smooth and round so as not to cut the silk. The silk is two thicknesses, the thin for a thin pedicle and the thick for a thick pedicle; it is pure Chinese twist, with no cotton in it. Every piece of silk is scalded in boiling water to get rid of the gum, then stretched tightly to test it and reset its fibres.

---

[1] L. Tait.

The sponges should be of the very best quality, should vary somewhat in size and shape, and should be perfectly free from tears or ragged points, from which pieces may become detached. When they are new soak them for twenty-four hours in a solution of muriatic acid sufficiently strong to be disagreeably sour to the taste; this dissolves the particles of chalk with which they are infested, and loosens the sand, which must be completely washed out of them. After each operation wash them free from color, and then soak them for forty-eight hours in a strong solution of washing soda, or ammonia, to dissolve the fibres; then wash them repeatedly until the water comes from them perfectly clean; they are now placed for a week in a well-made calico bag in a warm place till they are quite dry. At the operation but one nurse is allowed to touch them, and the exact number of twelve are always selected; they are counted before the operation, before the wound is closed, and again after the operation in order that a sponge shall not be left in the abdomen.

The patient takes the anæsthetic in bed to avoid having her disturbed by seeing the preparations. During the administration of ether there should be absolute silence in the room; no one should be allowed to talk; more particularly no allusion should be made to the patient, or to the prospects of the operation.

Because, for a long time after insensibility has apparently been reached, ideas may be picked up by the patient from suggestions made at the bedside, and these often have a lasting and most disagreeable effect. Whoever gives the ether should absolutely mind his or her own business, and take no interest whatever in the surroundings during the whole of the process.

The patient is now lifted upon the table; the arms and legs are secured by belts, and two clean towels are arranged so as to leave the abdomen exposed between them; the bladder having been emptied, and the arrangement of instruments, sponges, etc., being satisfactory, begin the incision midway between the umbilicus and the pubes and cut downward, through the skin and subcutaneous fat at one cut, about twelve and a half inches; then look for the white line and divide it to an equal extent; cautiously divide the fat and transversalis fascia until the peritoneum is exposed; pause and secure every bleeding point by a pair of scissors-forceps; open the peritoneum so as to admit the forefinger, and make a brief preliminary exploration; then lay open the peritoneum to an extent corresponding with the wound in the other tissues and expose the cyst; arrest any other bleeding immediately; now tap the cyst with a large-sized siphon trocar and empty it as quickly as possible; draw it gently out of the wound, if there are no adhesions.

There is a variety of trocars in use; the form much used has an attachment for seizing the cyst and a long tube (Fig. 781),[1] but a single long curved trocar and canula[2] (Fig. 782) has proved very efficient and serviceable.

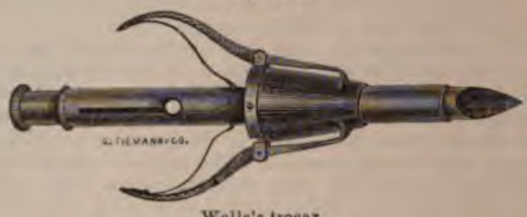
---

[1] Sir S. Wells.

[2] T. A. Emmet.

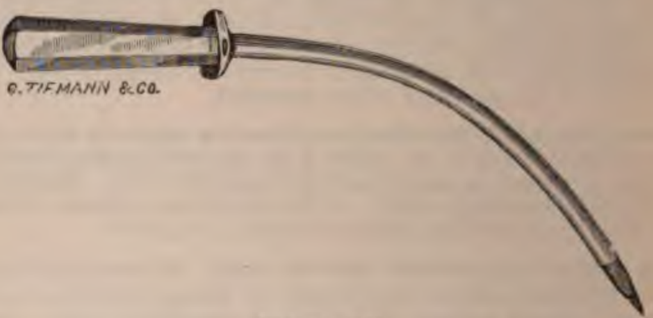
The assistant stationed opposite should immediately insert one or two sponges to prevent the exit of the intestines, take possession of the tumor and steady it while the surgeon examines the pedicle and determines how it may best be dealt with; for a thin pedicle use thin silk, and for a thick pedicle use correspondingly thick cord; pass an ordinary-handled needle, armed with a long piece of the silk required, through the pedicle and then withdraw so as to leave a loop on the distal side; draw this loop over the ovary or tumor and draw one of the free ends through it so that one end is above while the other is under the retracted loop (Fig. 783); seize both ends in the hand, draw them through the pedicle against which the thumb and forefinger of the left hand are pressed as a fulcrum, till complete constriction is made; then make a simple hitch and tighten, and follow this by another, as in ordinary ligature-tying; cut the pedicle through about a quarter of an inch on the distal side of the ligature and drop it back. Next examine the other ovary, and if this be found diseased, remove it in a similar way; carefully cleanse the peritoneal cavity from all blood-clots and other débris which may be in it by introducing two or three sponges into the cavity of the pelvis and

Fig. 781.



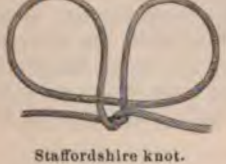
Wells's trocar.

Fig. 782.



Emmet's trocar.

Fig. 783.



Staffordshire knot.

the hollow of each loin, and then filling the whole abdomen full of tepid water by means of a tube running from a ewer or suspended cistern, closing the wound with one hand while the other is inside; move the fingers rapidly about among the intestines, and give them a good wash in the water; empty the cavity and refill it two or three times until the water comes away quite clear; if the water continues colored, immediately find the bleeding point and secure it; put a number of dry sponges down in the pelvis and over each kidney, and then proceed to insert the sutures in the wound; by the time this is accomplished the dry sponges have soaked up all the water, and the peritoneum is generally found quite clean and dry; if it is not, repeat the process until quite certain that nothing is left behind. Finally, take the utmost care with the sutures to see that they are ranged evenly, that they include all the structures of the abdominal wall, that the stitch-holes do not bleed, and that the wound is most accurately closed; never be satisfied to leave an eighth of an inch of gaping wound, and take the utmost care that the edges of the skin are in correct adaptation; always use silk sutures, and use a knot having two turns in its first hitch (Fig. 783), so that when this is tightened it does not slip before the second hitch is made and drawn up. For the first dressing use absorbent cotton-wool, made up into pads of different sizes and shapes, averaging about five inches square and from one and a half to two inches thick; place two or three of these over the wound and secure them in their places by two or three narrow straps of sticking-plaster, the whole dressing being covered by a cotton binder round the patient's waist, fastened with safety pins. This dressing is rarely touched before the fourth day, when fresh padding is adjusted; on the sixth or seventh day every alternate stitch is removed, and on the following day the remainder.

The conditions which may complicate the operation are considered as follows:—[1]

(*a*) **The dissection** is sometimes difficult. Adhesions between the tumor and the peritoneum in front may render it no easy matter to determine the point of union between the two membranes; the glistening peritoneum has been mistaken for the wall of the cyst and the operator has attempted to separate the former membrane from the transversalis fascia; even when there is no adhesion the peritoneum is sometimes so greatly altered in appearance, having become so thick, leathery, and gelatinous, as to deceive any but the most experienced operator; when the point of disease between the cyst and peritoneum cannot be discovered, it is better to cut cautiously inward until the cyst be opened, because then it can be emptied, the whole wall carefully taken up and examined, and the several parts accurately determined. This should be done with great caution, for a piece of intestine may lie in the way and be opened by mistake.

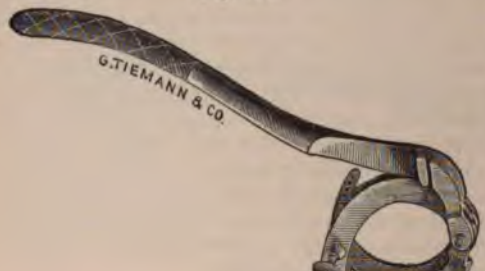
(*b*) **The contents** of an ovarian cystoma are sometimes glairy, or even perfectly gelatinous, and will not pass through a trocar, nor be seized by the hand, nor be lifted up by a sponge, and to remove it from a cyst is often a matter of the greatest difficulty; the walls of these cysts are generally thin and extremely fragile, so that they cannot be held by forceps; these tumors are also often very adherent, the adhesions bleeding very freely when broken down; the only course is to enlarge the incision to the extent of four or five inches, or even more, and to remove the mass by the hands as rapidly as possible, the assistant aiding by squeezing upon the flanks.

---

[1] L. Tait.

(*c*) **Adhesions** are mediate or immediate, the former being generally parietal or omental, existing as round or flattened bands of peritoneum; they are seldom large, and are only of any moment when traversed by an important blood-vessel, which must always be secured by torsion, ligature, or cautery; the immediate adhesions require great patience to overcome them, and even when they unite the tumors to the most important organs, they may be separated, or a piece of the cyst may be detached and left. Exceptional forms of adhesions involve the ureters, or attach the appendix vermiformis; in dealing with pelvic adhesions it must be borne in mind that the large venous trunks in that region lie immediately under the peritoneum and must be carefully avoided; hemorrhage from adhesions has always a very strong tendency to arrest itself, and most of the bleeding points will stop of their own accord, or can be stopped by simple pressure with a sponge; each point should be seized by a pair of scissors-forceps, or touched with a cautery, or a piece of solid perchloride of iron; for the arrest of a general oozing from a large surface the pressure of two or three dried sponges is generally enough; and it is well to separate these adhesions as rapidly as possible, and then apply the sponges, leaving them in place until the tumor is separated.

Fig. 784.



Clamp for pedicle.[1]

(*d*) **The pedicle** may be treated with the clamp, the cautery, or the ligature. The clamp should be reserved for extremely exceptional cases, viz., those in which the pedicles are thick and soft, and so short as to contain perhaps a small piece of tumor; with such pedicles the extra-peritoneal method is admissible; the clamp (Fig. 784) should apply circular constriction which will arrest all hemorrhage, will not cut the pedicle, and will allow the wound to be accurately adjusted around the stump.

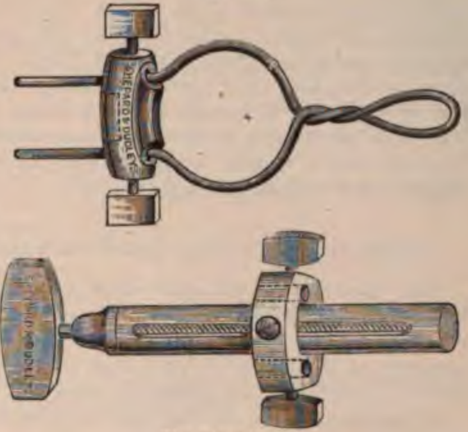
The wire clamp (Fig. 785) is used as follows:[2] After it has been placed around the pedicle the collar is run on close up to the tumor pedicle; the handle is then also run on, the ends of the wires running in the holes and the end fitting into a counter-sunk hole shown by a dotted line; the pinch-screws are then closed tightly down on the wires, the screws being quite loose; the handle is then turned slowly till the loop of wire firmly constricts the pedicle; the screws are securely tightened, and those on the handle loosened, the handle removed leaving the clamp with its collar in position.

The cautery[3] may be used after a clamp is fixed tightly upon the pedicle; the common cautery is used above the clamp at a dull-red or almost black heat, searing the pedicle very slowly but very completely; when the clamp is removed the short part of the pedicle which has been embraced by it is shrivelled and translucent, like parchment, and is dropped back into the cavity; the results are excellent. The application of the ligature has been given. As between the cautery and ligature, while no preference can be given to either as to results, the ligature is much more readily and rapidly applied. The success of both of the methods is believed to be due to the intra-peritoneal treatment of the pedicle.[1]

---

[1] T. G. Thomas. [2] L. Tait. [3] T. Keith.

Fig. 785.



The wire-clamp.[1]

II. THE FALLOPIAN TUBES.

The Fallopian tubes are closely associated with the ovaries, and are liable to be involved in the inflammation which attacks the latter. They are also liable by continuity of structure to be involved in the inflammatory affection of the uterus. As a result of inflammation in and around the tubes several conditions are now recognized which demand operative interference.

Hydro-salpinx, pyo-salpinx, hæmato-salpinx are forms of diseases of the Fallopian tubes. They are all due to a prior inflammation which has closed the tube; in one case the contents may be serous, in another purulent, and in a third bloody—the former being most frequent and the latter most rare. The pathological condition of most importance is practically the same in all these cases, and arises from an attack of acute or subacute oöphoritis or perioöphoritis; during this process the trumpet-shaped extremity of the tube approaches the ovary for its normal attachment, and, by the inflammatory process, becomes permanent; probably after the attachment has occurred the inflammatory process extends to the tubes, and occlusion occurs.[1] Menstruation now becomes excessively painful, and sometimes is attended with repeated attacks of pelvic peritonitis during these periods, which are now believed to be due, in a great majority of cases, to the escape of the secretions of the tube into the pelvic cavity.[2] The result of this inflammation is the complete interruption of the functions of the tubes and of the ovaries, and periods of intense suffering and entire loss of health. The diagnosis of inflammation of the tubes, and the accumulation of fluid in their cavities, may be made by the symptoms and the physical signs. The symptoms common to these cases are as follows:[1] 1. A history of severe pelvic inflammation, though sometimes this cannot be ascertained with precision; its origin is variously ascribed, as to a gonorrhœa, a chill, or sudden stoppage of menstruation, but most frequently inflammation after labor or a miscarriage. 2. There is always pain, which comes on after exertion, and especially after intercourse, and generally becomes intensified when menstruation appears; at this time the pain is often described as excruciating, and it lasts throughout the period. 3. There is, in the majority of instances, irregular and profuse menstruation, often amounting to hemorrhage. The physical signs are: 1. Swellings at the seat of the ovaries, which are always tender and generally quite fixed. 2. Distinct fluctuation can often be felt, and their peculiar sausage-like shape frequently enables the operator to diagnose the condition previous to the operation. The treatment now advised is removal of the uterine appendages.[1] The operation should be by abdominal section; the details are the same as for abdominal oöphorectomy.

---

[1] L. Tait.

[2] Bernutz.

III. THE PAROVARIUM.

The parovarium consists of a group of scattered tubules lying transversely between the ovary and the Fallopian tube, lined with epithelium, but having no orifice; the tubules converge, but remain separate at their ovarian end, and at the other are more or less distinctly united by a longitudinal tube.

Cysts may form in the parovarium, and are generally retention cysts. The walls are thin, and as they grow directly from the side of the broad ligament, they rarely have pedicles. They may enlarge so as to be of great size, but they rarely give rise to symptoms of any kind, and especially of urgency. The diagnosis is generally easy to the practised hand, for they give a uniform and very rapid wave of fluctuation in every diameter of the tumor; their shape is usually globular, but they do not project into the pelvis.[1] The treatment is by tapping or removal. Tapping is still advocated by some surgeons, but an authority of large experience remarks:[1] Their early removal is always simple and safe; they should never be tampered with by tapping, but ought to be removed by abdominal section in their early stages.

CHAPTER LIX.

THE UTERUS.

The uterus is a hollow organ, having an average length of three inches, a breadth at its widest part of two inches, and a thickness of one inch; its position corresponds with the axis of the inlet of the pelvis, its upper end being turned upwards and forwards.

It is covered behind, above, and in front, except where it is connected with the base of the bladder by the peritoneum; from its lateral surfaces the peritoneum is reflected, forming the broad ligaments; its neck is narrow and round, from six to eight lines in length, and projects into the upper end of the tube of the vagina; at the lower extremity is the os uteri, by which its cavity communicates with the vagina.[2]

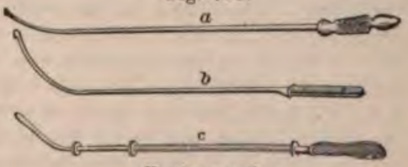
---

[1] L. Tait.

[2] Quain's Anatomy

Exploration of the cavity of the uterus is made with the uterine sound, by which it is possible to ascertain the capacity of the uterus; the existence of growths within it; deviations of the course of its canal; differentiation of displacements from uterine tumors; the existence of endometritis; the mobility of the uterus.[1]

Fig. 786.



Uterine sounds.

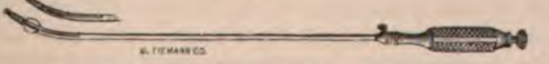
The uterine sounds *a*, *b*, *c* (Fig. 786), usually of metal, may be curved to suit any canal. For measuring the cavity, buttons may be applied to the shaft, *c*,[2] the end of the probe being in contact with the fundus, the section having a button on the end is projected until it comes in contact with the cervix, and the distance from the button to the end of the sound is the length of the cavity. A slender rod of whalebone, ending in a knob,[1] is useful for measuring a uterus enlarged by a submucous fibroid, and for separate measurement of the neck and body.

Place the patient on the back, and ascertain by the touch the position of the uterus; then introduce the speculum, and pass the sound curved according to the direction of the uterine canal; if it does not pass, change its curve to meet deviations, for success is attained only by properly curving the probe.[1] The tent is employed to dilate the cervical canal to allow of the examination of the cavity by the touch or sight; it may be made of sponge or of sea-tangle, laminaria digitata. The following rules[1] in regard to their use should be observed:—

(1) No force should be used in their introduction; if the first tent does not pass easily, withdraw it, and either bend it to a more suitable shape, or select a smaller tent. (2) Never introduce a tent at your office and allow the patient to go home with it in utero. (3) The previous existence of chronic pelvic peritonitis contra-indicates the tent. (4) A tent should never be allowed to remain in the uterus more than twenty-four hours. (5) After removal of a tent, wash out the vagina with antiseptic fluid; and, if there is pain or chilliness, give opiates. After the removal of a tent, the patient should be kept in bed for twenty-four hours.

Cervical constriction, causing dysmenorrhœa, is best treated by making a superficial incision through the submucous layers of the parenchyma from the os internum through the whole course of the canal. Introduce the hysterotome (Fig. 787)[1] up to the os internum, turn the screw at the end of the handle, by which the two blades are thrown out, and withdraw the instrument; place within the canal a

Fig. 787.



Hysterotome.[3]

---

[1] T. G. Thomas.   [2] A. J. Skene.   [3] O. White.

roll of cotton saturated with a weak solution of persulphate of iron, and allow it to remain forty-eight hours, then change; at the end of a fortnight replace it by a stem of glass or vulcanite.

Retroversion of the uterus, occurring suddenly from a fall, is attended with severe symptoms; the patient falls to the ground and is unable to rise, experiences the severest pelvic pain, suffers from suppression of urine and feces, and is often in such agony that the face is bathed with perspiration, and the pulse becomes weak and fluttering. The finger in the vagina discovers the cervix near the symphysis pubis, and a hard, round mass resting upon the rectum; if there is doubt in the diagnosis, use the uterine probe which will determine the direction of the axis. Place the patient on the left side, in a semi-prone position, as for a speculum examination; standing at the patient's back, and facing her head, introduce the index and middle fingers of the right hand, well lubricated, the palmar surfaces directed to the rectum; lift the uterus upon the inner surfaces of the fingers until it becomes erect, then their dorsal surfaces, or backs of the nails, are made to push the organ into position.

If the uterus is irreducible, and requires more powerful means,[1] evacuate the bladder and rectum, loosen the clothing, have the patient kneel upon a hard surface, with the sternum as closely as possible in contact with the same plane; introduce the two fingers into the vagina, place them against the fundus, and direct the patient to fill the chest with air and expel it completely; at this moment, elevate the fundus, and restore it to its place. If this effort fail, elevate the hips still more, and repeat the attempt with the fingers in the rectum, instead of the vagina.

Uterine polypus[1] is a tumor covered by the mucous membrane of the uterus and attached to that organ by a pedicle. The symptoms are leucorrhœa, pain in the back and loins, menorrhagia, metorrhagia, and hydrorrhœa; if the tumor is attached to the cervix it may be felt hanging from the canal or in the os uteri; if it is in the cavity, and small, its presence will not be detected by the sound, but there is often a copious flow of blood following the withdrawal of the instrument; if large, the uterus will be displaced and enlarged, and the cervix somewhat dilated. But no examination can be considered complete until the cervix has been fully dilated by tents and exploration has been made by touch. If a polypus exist in utero and the cervical canal be firmly closed, avoid immediate attempts at removal, unless the symptoms are grave; employ palliative measures until dilatation of the cervix, and, perhaps, expulsion into the vagina are effected; to facilitate expulsion, dilate by tents, or incise the walls of the cervix laterally, and use ergot steadily, either internally or hypodermically; if the os internum be fully dilated, and the tumor be in utero, seize it with a volsellum at its lowest extremity, and make a cautious, but rapid, attempt at its removal by torsion and traction, but lengthy manipulations in utero are always very hazardous; if it cannot be removed in this way, slide up along the wall of the tumor, upon which steady traction is made, an écraseur or a pair of sharply-curved scissors, and sever the stem.

---

[1] T. G. Thomas.

Fibrous tumors of the uterus[1] are submucous, interstitial or sub-peritoneal. The more frequent symptoms, especially of the submucous variety, are menorrhagia, irritability of rectum and bladder, pain through the pelvis, uterine tenesmus, profuse leucorrhœa, dysmenorrhœa, pressure on the crural veins and vessels, watery discharge from uterus. Exploration should be conducted as follows: Place the patient on the back, with the thighs flexed; all constriction of the waist should be removed and the bladder and rectum emptied; depressing the uterus by the right hand placed over the hypogastrium, sweep the index-finger of the left as high up as possible over the posterior wall, first by vaginal and then by actual touch; lift the uterus with the fingers within, and force the tips of the fingers on the abdomen behind the fundus, and downwards over the posterior wall so as to approach the fingers in the pelvis, and thus explore this region; next, draw the cervix forwards with the finger in the vagina and pass the fingers external over the anterior wall, and explore; to examine the cavity, dilate the cervix fully by tents of sponge or sea-tangle, and, on their removal, depress the uterus and introduce the finger. Methods of treatment applicable to all uterine fibroids are absorption, excision, avulsion, enucleation. Absorption has been effected by the persistent use of iodine and ergot; the former in large doses of the iodide of potassium, and the latter by hypodermic injection of the aqueous extract of ergot three parts, to glycerine seven and a half parts, and the same of water. Excision, avulsion, and enucleation require dilation of the cervical canal. If a small tumor project it may be removed by the knife, scissors, or other cutting instrument; but if the écraseur can be used, it should be preferred; should the tumor be very large and fill the vagina, it may be drawn down by obstetric forceps; or it may be cut away, piece by piece, by knife or scissors, and removed until the base is reached; or the galvano-cautery or écraseur may be used, portion after portion being removed. Avulsion is practised with vulsellum forceps, firm traction with slight rotatory movement being made; if the tumor do not yield, introduce one hand into the vagina and two fingers into the uterus, and rupture the attachments of the growth. Enucleation is preferred when the tumor is so much imbedded that other methods are unavailing; the cervical canal being previously fully dilated, place the patient on her back, upon a strong table, and, while an assistant firmly depresses the uterus, by means of a pair of scissors, guided by two fingers, cut into the capsule, and into this opening pass the index-finger, and fix the tumor; by means of scissors or a probe-pointed bistoury, make a crucial incision through the capsule as freely as circumstances will admit; now pass one hand cautiously into the vagina, and forcing the uterus towards the vulva, with the other proceed to peel back the capsule and enucleate the mass. Or, a long crucial incision may be made over the presenting part of the tumor, the lips of the capsule separated by the finger, and the patient put upon the systematic use of ergot, in the hope that the body of the tumor may be expelled by uterine efforts.

---

[1] T. G. Thomas.

The Cæsarean section is an operation undertaken to remove the child from the uterus in cases of extreme contraction of the pelvis, or of the sudden death of the mother. Empty the bladder; make an incision in the median line from the navel, nearly to the pubes, and expose the uterus; while it is supported, laterally, incise the walls between the fundus and cervix; rupture the membranes, and remove the child by the feet; pass the hand between the anterior wall and membranes, and remove the placenta; prevent hemorrhage from the uterus by pressure or cold, cleanse the cavity and vagina of all coagula with carbolized solutions; close the wound of the uterus by carbolized catgut sutures, cut short, and the abdominal wound with wire sutures. Observe all the usual antiseptic precautions.

Utero-ovarian amputation as completive of the Cæsarean operation[1] consists in first performing the ordinary Cæsarean operation so far as relates to the removal of the fœtus and contraction of the uterus; then the uterus is drawn through the abdominal wound, its neck ligated by a wire constrictor tightened by a screw power; the organ is next cut away above the loop and the stump secured in the lower angle of the abdominal wound.[2]

The design of this change is to avoid the possibility of the escape of post-partum uterine fluids into the abdominal cavity, and the dangers consequent thereupon, by converting the uterine wound, with its disposition to gape open, into an open stump, external to the body, and discharging externally under antiseptic dressings. This operation has proved much more successful than Cæsarean section. Several modifications have been made, viz., the uterus has been drawn out of the abdomen and the constriction applied before the uterus was opened;[3] the application of elastic tubing to the neck before opening the uterus;[4] the stump has been ligated and dropped into the pelvis;[5] a double flap has been made and then stitched, and the stump returned.[6] The Porro operation saved $46\frac{14}{41}$ per cent. of the cases; the Porro-Müller method $52\frac{16}{17}$ per cent; the two combined, $48\frac{8}{29}$ per cent. of the women and 90 out of 118 children.[2]

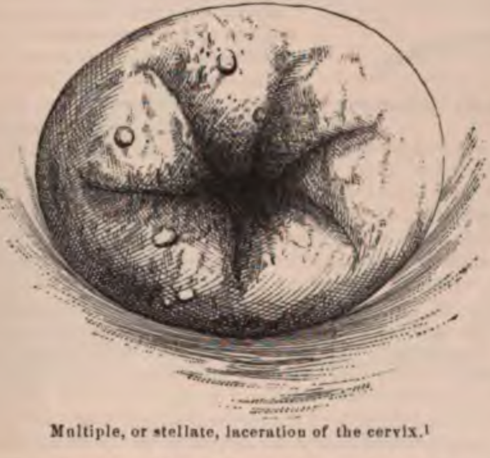
Laparo-elytrotomy,[7] dilatation of the cervix, section of the abdominal wall, and of the vagina, has been recommended, as involving less danger to the mother, because avoiding section of the peritoneum. In actual practice it is said to have given much better results than Cæsarean section.[8] The operator should be provided with a pocket-case of instruments, ether, dilators, and thermo-cautery, or, in place of it, ordinary cautery-irons. The patient having been etherized, should be placed upon a firm table, and the os fully dilated by dilators. The abdominal wound should be made thus: With a bistoury cut through the abdominal muscles, the incision being carried from the spine of the pubis to the anterior superior spinous process of the ilium; separate the lips of the wound, and by two fingers lift the peritoneum, so that the vagino-uterine junction is reached; lift the vagina by a steel sound passed within it, and cut and enlarge the opening by the fingers; lift the cervix into the iliac fossa by the blunt hook, while the fundus is depressed in an opposite direction; then pass the right hand into the iliac fossa and introduce two fingers into the uterus, while the left hand, placed on the outer surface of the uterus, depresses the pelvic extremity of the fœtal ovoid; deliver the child by version, if the head or arm present; by extraction, if the breech do so. The placenta having been delivered, and the uterus caused to contract firmly, the iliac fossa should be cleansed by a stream of warm water, introduced through the abdominal wound, and escaping through the vagina; and if hemorrhage exist, ligatures should be applied, if possible through the abdominal wound, to the bleeding vessels. Should this prove impossible, the vagina should be distended by a large metallic speculum, and the lips of the abdominal wound being widely separated, the bleeding points touched by the actual cautery carried down from above. Should this fail, the uterus should be made to contract firmly by ergot, and both vagina and iliac fossa be thoroughly tamponed with cotton soaked in water and squeezed, but free from any styptic. Then a broad band of adhesive plaster and a compress should be applied over the lower portion of the abdomen. Should no undue hemorrhage occur, the abdominal wound should be closed by interrupted silver sutures; the vagina should be syringed out every five hours with warm carbolized water, the nozzle of the syringe being carried through the vaginal opening, and the fluid forced out through that in the abdomen. The patient should be kept perfectly quiet, and be nourished by milk and animal broths; pain should be relieved by opium.

---

[1] E. Porro.
[2] R. P. Harris.
[3] Müller.
[4] Esmarch.
[5] G. Veit.
[6] Wasseiger.
[7] T. G. Thomas; A. J. Skene; H. J. Garrigues.
[8] H. J. Garrigues.

Laceration of cervix uteri[1] is an ordinary event of parturition. The rent may assume many forms, ordinarily it is single, but may be double, or multiple (Fig. 788). The diagnosis is made with the single-blade speculum, the patient lying upon the left side; the surface of the lacerated part is bright red; with the tenacula the two lips of the wound may be approximated when the red surface disappears.

Fig. 788.



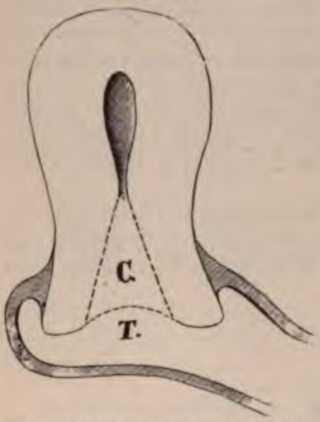
Multiple, or stellate, laceration of the cervix.[1]

---

[1] T. A. Emmet.

But comparatively few of the many lacerations require other treatment than such local remedies as will relieve inflammations, viz., hot water injections and tincture of iodine. The simple existence of a fissure in the cervix, therefore, does not justify an operation for its closure nor should the operation ever be resorted to except for the relief of symptoms which remain after the accepted treatment has been employed without apparent benefit; it is only when reflex symptoms exist, with the enlargement of the uterus, after cellulitis has been fairly removed, and when the woman suffers from neuralgia or persistent anæmia, an operation is necessary.[1] The operation for the cure of this condition is trachelorraphy.

Fig. 789.



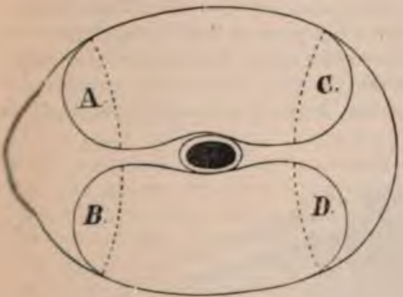
Catrical plug in the lacerated cervix.

Success in the operation for the relief of this accident requires the operator to understand precisely the conditions which exist in a well-marked case. In the effort at repair there is often a large amount of dense cicatricial tissue which must be removed before the parts can be brought into easy apposition (Fig. 789); apparently the limit of the laceration is along the dotted line *T*, and the extent of injury seems very superficial when in fact it may have been very deep; when this surface has been denuded only to *T*, and the sutures have been introduced, the operator will be surprised at the difficulty experienced in bringing the parts properly together; the effect of closure over this plug is seen if a wooden spool is placed in the angle between two fingers, and then an attempt is made to bring the sides of these fingers in apposition; it can be done by force, but the circulation is at once obstructed, and so the lips of a laceration would meet with similar resistance if this cicatrical plug was shut up between them, and sutures would be likely to cut out. When the parts have been thus closed, shutting up this mass of cicatricial tissue, there will be no improvement even should they unite perfectly; the uterus will remain quite as large as before and frequently will even increase in size; the congested condition of the neck will show that the circulation is obstructed, and an erosion soon forms; a fresh attack of cellulitis is not usual; there will be a marked increase of the anæmia and neuralgia. The only remedy is to remove the whole mass on both sides in a V-shape and secure the surfaces thus made with sutures. The position of the uterus should be disturbed as little as possible, as so extensive a laceration produces cellulitis at the time of occurrence, and if the uterus is dragged down at the time of the operation a fresh cellulitis will follow. Again, when the case has been of long standing many cysts will have formed and ruptured from which cause contraction takes place along the edges of the mucous membrane of the canal and vaginal surface, converting the former flat sides of the flaps into two convex surfaces in apposition with each other; freshening these surfaces in a superficial manner and attempting to bring them together would fail to approximate the outer edges properly unless the sutures were twisted so tightly that they would cut out. Not only is it necessary to remove this projecting surface entirely, but even partially to excavate that the sides of the flaps may be brought into close contact throughout when the sutures have been secured. The lines *A B* and *C D* (Fig. 790), indicate the portion to be removed, but this removal is not to extend entirely across the flap, for if this were done there would be a complete closure of the cervical canal; nor is the removal necessary to this extent since the hypertrophied portion represents the amount to be denuded. This appears in a horizontal plane of the cervix (Fig. 791): the hypertrophied tissue is indicated by *A*, *B*, *C*, *D*, and is to be removed to the bottom of the laceration along the dotted lines, so that the surfaces *A* and *B*, *C* and *D*, can be brought together by sutures.

---

[1] T. A. Emmet.

Fig. 790.



Cicatricial hypertrophy after laceration.[1]

Fig. 791.

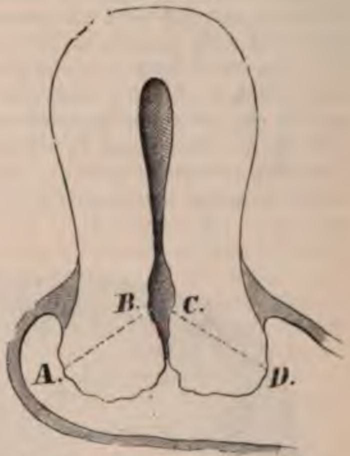
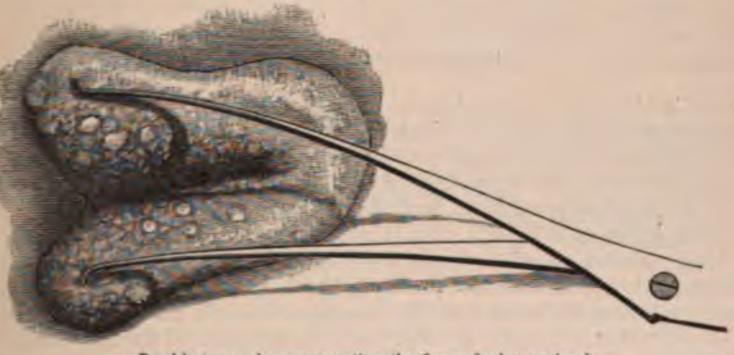


Diagram of surfaces to be denuded.[1]

Trachelorraphy, operation for closing a lacerated cervix, is performed as follows:[1] Administer a large hot-water vaginal injection to lesson hemorrhage; place the patient on the left side and use Sims's speculum, or some other perineal retractor, to bring the parts into

Fig. 792.



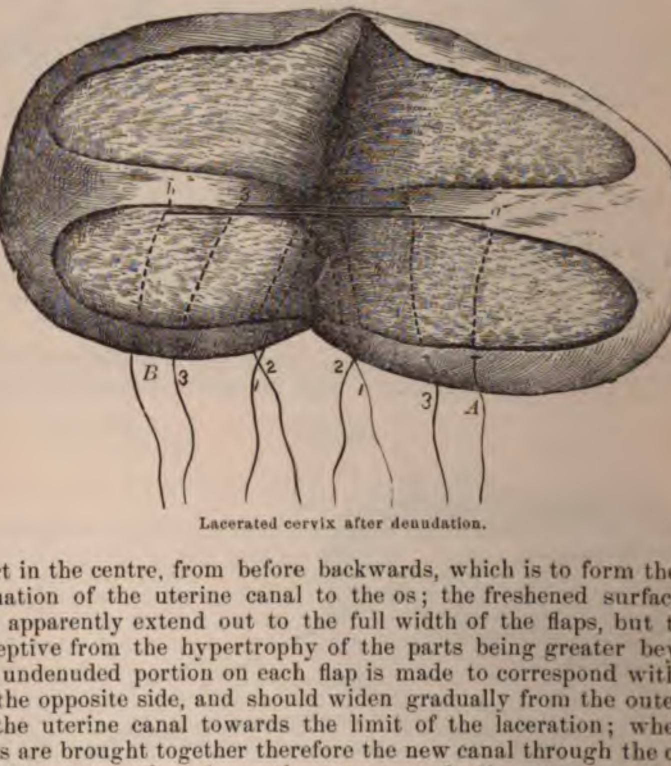
Double tenaculum, separating the flaps of a laceration.[1]

---

[1] T. A. Emmet.

view; at the beginning of the operation it is always necessary to open out the flaps so as to expose fully the lacerated surfaces which are to be denuded, and the double tenaculum in the hands of an assistant will be found useful to keep the flaps apart, and to steady the uterus while the angle is being denuded (Fig. 792); the scalpel or scissors may be used to freshen the surfaces, but the tissues can be removed with greater rapidity with the scissors, and the scalpel may be most serviceable to denude the angle at the bottom of the laceration when confined to one side if the tissues are dense. The extent of the tissues to be denuded, and the direction in which the sutures are to be introduced in double laceration may be appreciated by the illustration (Fig. 793). As shown by this figure the surface is to be removed from one lip to the other, leaving a broad undenuded tract in the centre, from before backwards, which is to form the continuation of the uterine canal to the os; the freshened surfaces do not apparently extend out to the full width of the flaps, but this is deceptive from the hypertrophy of the parts being greater beyond; the undenuded portion on each flap is made to correspond with that on the opposite side, and should widen gradually from the outer end of the uterine canal towards the limit of the laceration; when the flaps are brought together therefore the new canal through the cervix will be trumpet-shaped; as the uterus gradually returns to the normal size, this new canal will become of a natural and uniform diameter throughout; to make this canal of a proper size we must be guided by the amount of hypertrophy in the flaps, and it must bear some relation to their increased size; the trumpet-shape is necessary, since the hypertrophy increases in degree from the bottom of the laceration towards the outer edge of the flap. When it is safe to do so, the

Fig. 793.



Lacerated cervix after denudation.

process of freshening the surfaces is very much facilitated by drawing the uterus gently down towards the vaginal outlet, and then having the organ steadied by a strong tenaculum in the hands of an assistant; the nearest portion, or that which is lowest, should be removed first to avoid the blood obscuring the surface; the portion to be removed is to be hooked up with a small tenaculum, and the strip kept on the stretch while it is being separated, and, if possible, it should be removed in a single piece from the side of one flap to the other. The freshened surfaces should be made as smooth as possible, and uniform in extent. Four sutures or more are required for each side if the laceration is extensive or double. Under ordinary circumstances no device, however ingenious, can possibly be found to take the place of a proper sized needle which can be held at any angle in the forceps. When the bleeding has been troublesome, it is advisable to pass the first suture through the vaginal tissue a short distance below the angle of laceration, which will secure the circular artery or its branch; in double laceration the sutures had better be introduced by beginning in the angles and insert afterwards in turn, first on one side and then on the other. The sutures should be introduced from A at the outer portion of the flap, to a, at the edge of the surface which is to form the canal, and then from within outwards, through the other flap from a, to B so as to correspond. Under ordinary circumstances a suture can only be introduced by drawing out or forward the uterine tissue forming the angle of the wound so that from this point on each side a needle armed with a silk loop may be passed from within outwards and a continuous suture gained by withdrawing the one into the loop of which the end of the other had been passed; to the silk loop a silver suture can be easily attached in the usual way and drawn through. The sutures are next twisted, bent over so as to lie close to the surface of the neck and cut off at half an inch in length.

Tumors of the uterus may be, 1, fibro-myomata; 2, fibro-cysts; 3, sarcomata; 4, carcinomata. These tumors are now treated by removal; if accessible through the vagina, as submucous fibroids, or cancer of the cervix, they may be attacked directly, and either removed, or the portion of the uterus involved may be excised. If they involve the body of the organ, extirpation of the uterus itself is the rule of practice.

Cancer of the uterus is, in at least half of the cases, in the form of an epithelioma; it originates from the mucous lining of the cervix or from the vaginal portion, and may give rise to very extensive lesions in the uterus, and may lay open the bladder, rectum, or peritoneal cavity. The symptoms are pain through the pelvis, tenderness upon movement or coition, menorrhagia, ichorous and fetid leucorrhœa, hydrorrhœa, dark and grumous discharge, constitutional debility, pallor and cachectic facies, fistulæ. The touch detects, before ulceration, a hard and nodular tumor, which is not characteristic, but after ulceration the finger discovers the walls of a deep and ragged ulcer, covered with a crumbling mass which readily bleeds. The treatment is to secure cleanliness by tepid vaginal injections of antiseptics and astringents, nourishing diet, anodynes, removal by means of the electro-cautery, if possible; if adhesions render removal impossible, practice partial removal or destruction by galvano-cautery, the scissors, scoop, or curette, or by actual cautery, fuming nitric acid, or anhydrous sulphate of zinc. Caustics carefully applied to the ulcerated surface, often give great relief by arresting the destructive process and diminishing the discharges. Removal of the uterus is now performed as a radical measure.

Hysterectomy, extirpation of the uterus, may be vaginal or abdominal.

1. **Vaginal hysterectomy** is performed as follows: If the patient has a fetid carcinomatous ulcer of the vaginal portion, or of the external os, scrape out with the sharp spoon the decayed portion several days before the operation, wash out the vagina daily with carbolic acid solution, 1–50, and after each washing fill the vagina with salicylated absorbent cotton. During this period give liquid food, and mild cathartics. At the operation cleanse the external parts with soap, nail-brush, and bichloride solution, and shave off all of the hairs, wash out the vagina with the disinfectant solution; place the patient in the lithotomy position, and dilate the vagina with long-bladed specula held against the anterior and posterior walls; seize the vaginal portion of the uterus with strong vulsellum forceps and draw it down as far as possible towards the vulva; now make a circular incision through the mucous membrane of the fornix of the vagina around the lower end of the cervix and separate the loose submucous cellular tissue from the cervix by means of blunt instruments, or curved scissors; next pass two loops of heavy silk through the middle or upper portion of the cervix by means of which it may be drawn down more easily; on the lateral surfaces it will be necessary to use the knife or scissors, and bleeding vessels will appear which must be ligated, and if hemorrhage is too great, the abdominal aorta may be compressed. The uterus being drawn firmly downwards and backwards, the loose connective tissue between the bladder and uterus is separated with a blunt instrument, until the peritoneum is reached; make a small opening in the median line, and pass the finger into the vesico-uterine fossa; with the finger as a guide enlarge the opening on both sides, keeping close to the uterus, until the anterior surface of the broad ligaments is reached. Now draw the uterus upwards towards the symphysis pubis and pass one or two fingers through the anterior cul-de-sac, hook around the fundus, pass them into Douglas's cul-de-sac, and open it on the point of a finger as a guide. The fundus of the uterus is now adherent only by or suspended in the lateral ligaments, and to bring the latter into view it is necessary to seize the fundus and evert it; this may usually be effected by combined manipulation with the index-finger of each hand, but when the fundus is large or the ligaments short and tense, it may be necessary to seize it with vulsellum forceps introduced through the vesico-uterine fossa as it is pressed forwards by the finger in Douglas's fossa, and evert it through the vesico-uterine fossa into the vagina. The ligaments are now to be separated; this should be done by passing a strong double silk ligature through the centre of the ligament and tying each half, and then placing a strong ligature around the whole, external to the double ligature; or the ligaments may be divided into several parts, and each ligated. The ligaments are now divided a little external to the ligatures. The peritoneal wound may now be united to the vaginal wound and the vagina filled with iodoform gauze; the dressings should be changed in three or four days.

This original operation has been variously modified, as follows:[1] The uterus is drawn firmly down by hooks, the vagina separated from the cervix by a circular incision, the cul-de-sac opened, the uterus everted through one or the other wound, the hooks removed from the cervix and engaged in the fundus, the peritoneum secured from retraction by threads of silk, the broad ligaments tied in three portions, the uterus liberated, the peritoneum closed, and the supra-vaginal wound closed around a drain and tampons of iodoform gauze used.[2] 2. Circular vaginal incisions; uterus drawn down; cervix loosened from bladder and rectum; posterior cul-de-sac opened; finger passed over broad ligament, and anterior cul-de-sac opened; uterus retroverted; broad ligaments tied *en masse*, first by one ligature and afterwards with two; these ligatures cut short and left in abdomen or fastened in angles of wound; peritoneal wound left open, but supra-vaginal wound closed around tube.[3] 3. Cut anteriorly and posteriorly, leaving the lateral walls intact until the uterus is turned out: invert the uterus through the posterior wound; pass a thick provisional ligature around each broad ligament, including the lateral vaginal wall, and divide uterus vertically into halves before removing it; ligate vessels separately in stumps and in vaginal wall; sink stumps, using no sutures, and close vagina with carbolized tampon.[4] The best results have been obtained where the peritoneum has been united to the mucous membrane of the vagina, closing the supra-vaginal wound. Leaving the supra-vaginal wound open, with a drain or without a drain, and uniting the supra-vaginal wound around a drain, all show results up to the general average, while the complete closure of the supra-vaginal wound, by approximating its edges without drainage, has had bad results, whether the peritoneal cavity were left open or closed. That the mortality is much influenced by the method of treating the peritoneal and vaginal wounds, is shown by the following facts:[1] Peritoneal wound closed, supra-vaginal wound open, with drain, gives a mortality of 40 per cent.; without a drain, 50 per cent. Peritoneal and supra-vaginal wounds closed, with drain, mortality 13 per cent. Peritoneal and supra-vaginal wounds open, with drain, give a mortality of 24 per cent.; without drain, 22 per cent. Supra-vaginal wound closed, edges brought together, with drain, mortality 25 per cent.; without drain, 50 per cent. Supra-vaginal wound closed, peritoneum sewed to vaginal wall, with drain, mortality 21 per cent.; without drain, 14 per cent.

2. **Abdominal hysterectomy**[5] is performed as follows:[6] Cleanse and disinfect the external surface; empty the bladder, and leave the catheter in as a guide; thoroughly wash out the vagina with carbolized water, and observe the most careful antiseptic precautions. Make an incision in the median line extending downwards to the symphysis pubis, and, unless the abdominal walls are unusually lax, the recti are partially divided on each side at their insertion into the pubis; open the peritoneal cavity, remove the intestines from the pelvis, and retain them with hot, flat carbolized sponges. Seize the uterus with suitable forceps, and draw it out of the pelvis. Ligature the broad ligament on both sides in three portions thus: The uterus being drawn over to the opposite side to make the ligament tense, arm a needle with double prepared silk suture, and pass it from behind through the ovarian ligament; carry one of the free ends of this suture through the broad ligament just below its free margin, and the other end through the round ligament; two loops are thus formed which, when tied, control the ovarian artery and the pampiniform

---

[1] S. E. Post.
[2] Czerney.
[3] Schroeder.
[4] Müller.
[5] Freund.
[6] A. H. Barbour.

plexus. Another ligature is passed from the vagina, on a curved needle, sheathed in a trocar; the needle is made to pierce the lateral fornix, and, when tied, it controls the uterine artery. The suture having been completed on both sides, carry the knife through the utero-vesical pouch between the cervix and the bladder, the position of the latter being defined by the catheter; the free edge of the divided peritoneum, resting on the bladder, is fixed to the underlying tissue by a fine silk ligature. Next cut through the peritoneum of Douglas's pouch at a lower level, and fix the free margin in a similar manner with a fine silk ligature; separate with the finger the cellular tissue underneath the peritoneal wound before and behind the uterus, and divide the mucous membrane in the anterior and posterior fornices with the knife passed in from the vagina; separate the broad ligaments with scissors internal to the three ligatures, and remove the organ. Bring the ligatures out into the vagina, and close the vaginal vault; insert a T-shaped drainage-tube, and fill the vagina with iodoform gauze. Close the abdominal wound and the peritoneum with fine prepared silk, the muscular layer with wire, and the skin with fine silk; apply iodoform dressings.

Supra-vaginal hysterectomy is the removal of the body of the uterus, leaving the vaginal portion of the cervix. The operation is required for tumors of the uterus. The following conditions are regarded as adapted for this operation:—[1]

1. Very large, rapidly growing tumors, weighing upwards of twenty pounds, of all kinds in young women. 2. Fibro-cystic tumors, if they can be removed, and all suppurating tumors. 3. Most soft œdematous fibrous tumors. 4. Large bleeding fibroids of any age, provided the patient is not approaching fifty years of age, and her life is practically useless. 5. Tumors surrounded by free fluid, the result of peritonitis, provided the fluid shows a tendency to reaccumulate after two or three punctures.

The ordinary operation is as follows:[2] The usual antiseptic precautions having been taken, make an incision in the median line as for ovariotomy; open the peritoneum and with the fingers determine the condition of the parts; enlarge the wound to admit the necessary manipulations; grasp adhesions with clamp-forceps and divide them on the distal side; rotate tumor and draw it up through the abdominal wound, enlarging the wound, if necessary, twelve or fourteen inches. Separate the bladder carefully from the tumor; ligature the broad ligaments as far from the tumor as possible, with two stout ligatures, and divide between the two points; if adherent to the tumor, remove them with it; all pelvic adhesions should be treated like the first with clamp-forceps. Place a temporary clamp or elastic ligature around the base of the tumor, and rapidly cut away the mass above. Examine the adhesions and apply catgut or prepared silk to every bleeding point as the clamp-forceps are one by one removed. Cleanse the entire cavity with sponges and proceed to apply the permanent clamp to the pedicle or stump. This clamp should be placed below the temporary clamp or ligature, unless it will make too great traction when placed outside the abdomen. Now shave down the pedicle to within a quarter of an inch of the clamp, apply the actual cautery,[1] and, if there is any liability of slipping of the pedicle, pass two or three pins obliquely above the clamp. Examine the pelvis again to see that it is dry, and proceed to close the wound as in ovariotomy. The stump should be dressed by stitching the peritoneum to the margin of the wound; complete the dressing with iodoform.

---

[1] T. Keith.

[2] C. C. Lee.

The following is a brief description[2] of this operation as performed by one of the most successful operators:[3] In the beginning the operator and his assistant were careful to wash their hands in pure water and soap; the instruments were in warm water, as also the sponges, with no other antiseptic precautions of any kind. He did not make a very long incision considering the size of the tumor. By means of his modified Koeberlé's scissors-forceps, he controlled the hemorrhage and lifted up the layers of tissue, pausing only on reaching the subperitoneal fat to see that all hemorrhage was thoroughly controlled. After the tumor was well exposed, he slipped over the fundus and about its neck his rope écraseur, drawing it tightly; then took an ordinary corkscrew, large, heavy, and with broad flanges, and screwing it directly into the fibroid, lifted it outside the abdominal cavity with comparative ease, thus far having passed only two fingers into the cavity of the abdomen, as done at first to examine appendages and to arrange rope of écraseur. He now placed about the neck of the tumor, or rather uterus, his wire clamp, and when well secured, the rope was removed, and tumor cut away with scissors, scarcely any hemorrhage being observable. The peritoneum and tissues were now brought together by sutures, thus in a measure covering the stump amputated. Incision in abdomen was closed by interrupted sutures, the cavity of pelvis being sponged dry, feeling assured that no bleeding had occurred, or was now going on from edges of the stump. Incision was dressed by simple pads of absorbent cotton and gauze, held in position by adhesive plaster. The operation lasted nearly an hour, and the patient was put to bed with cans filled with hot water placed about her, reaction coming on promptly. She was soon conscious, with scarcely any vomiting following; was allowed only warm water to sip, little being given for the first twenty-four hours. Two nurses were given this patient exclusively, the temperature and pulse taken every six hours, and absolute rest afforded. Patient made a good recovery.

Shortening of the round ligament[4] consists in dissecting out the round ligaments of the uterus, drawing them up, and fastening them in the wound. The indications for the operation are given as follows:[5] Prolapse of the uterus; retroversions and retroflexions of the uterus in which the organ can be placed in the normal position, and yet a pessary cannot be comfortably worn; prolapse of the ovary, the organ being reducible and not large enough or diseased enough to demand removal. The operation is as follows:—[5]

The patient is prepared for the operation; ether given; all the parts about the pubes and the vagina disinfected. Commencing at the spine of the pubis make an incision, parallel to Poupart's ligament, two inches or more in extent; the first objective point is the tendon of the external oblique muscle, for in that lies the external inguinal ring: having reached it, place a finger on the pubic spine, and slide it upward and outward about half an inch, then the depression of the ring will be felt; next clear away all the fat and connective tissue which cover the tendon of the oblique muscle about the ring; a mass of fat and vessels is exposed and sometimes the reddish fibres of the round ligament are seen rising and falling with the respiratory movements; this mass should be drawn out when the round ligament will come into view; grasp it with the forceps and isolate it. Repeat the operation on the opposite side. The uterus should now be placed in its normal position, unless it is prolapsed, when it must be pushed as far up and forward as is compatible with safe pressure, with a bulbous sound introduced into the uterus. The ligaments should now be drawn moderately taut, and stitched to the anterior face of the pubic bone, carefully prepared fine silk being used, three to each ligament. Cut the ligatures short, and also cut away the loose ends of the round ligament. If the ring gapes, or if the canal has been opened, carefully stitch together the columns with silk. Close the wound, using deep silk sutures; place aseptic cotton tampons in the vagina for forty-eight hours. Keep the patient in bed a month. Some operators make but one incision just above and parallel to the crest of the pubes extending to the outside of each pubic spine.

---

[1] Paquelin.
[2] A. Vandevere.
[3] L. Tait.
[4] Alexander.
[5] W. M. Polk.

CHAPTER LX.

THE VAGINA.

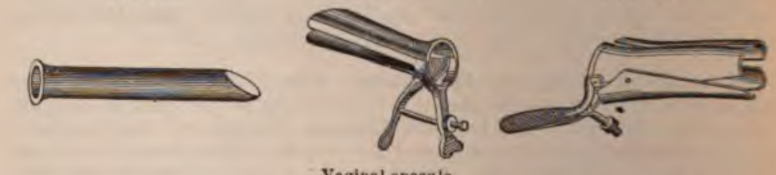
THE vagina is a membranous and dilatable tube, extending from the vulva to the uterus, the neck of which it embraces; it rests below and behind, on the rectum, supports the bladder and urethra in front, and is inclosed between the levatores ani muscles.[1]

I. EXPLORATION OF VAGINA.

Exploration of the vagina[2] is made with the fingers and the speculum.

(1) If the fingers are used, place the patient on the back, with the legs flexed and hips near the edge of the table; the index-finger introduced will determine the capacity of the vagina, the existence of growths, the position of the cervix uteri; abdominal palpation should always be combined with the vaginal touch; if more extensive examination is required, two fingers may be introduced, or even the whole hand, but in this case anæsthesia is generally necessary, and the greatest caution should be exercised; to explore the posterior region, turn the patient on the left side. (2) The speculum permits of visual examination; this instrument may be (*a*) cylindrical, and of this form none compare in elegance, cleanliness, and utility with the glass tube, coated

Fig. 794. Fig. 795. Fig. 796.



Vaginal specula.

---

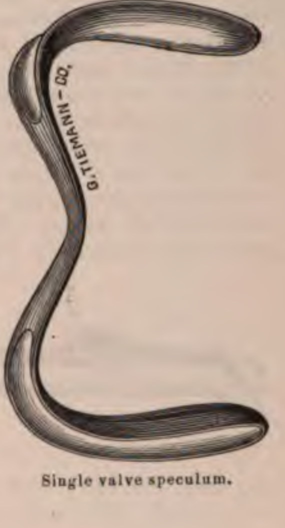
[1] Quain's Anatomy.

[2] T. G. Thomas.

with quicksilver, covered with rubber, and thoroughly varnished (Fig. 794); (*b*) bivalve (Fig. 795) and quadrivalve (Fig. 796); (c) single valve (Fig. 797). The best position for the patient in the use of these specula is upon the back, as already explained; first depress the perineum with the tip of the conical speculum, well lubricated with soap, oil, or vaseline, and then carry it up to the cervix; insert the valvular instrument closed, and expand it when in position; on removal avoid catching the mucous membrane between the blades. In the use of the single valve, place the patient in a position between that on the back and on the face, the left arm drawn behind so as to let her rest on the left side of the chest, and the right leg so flexed as to let the right knee lie just above the left; the speculum is gently introduced with the convexity towards the perineum.

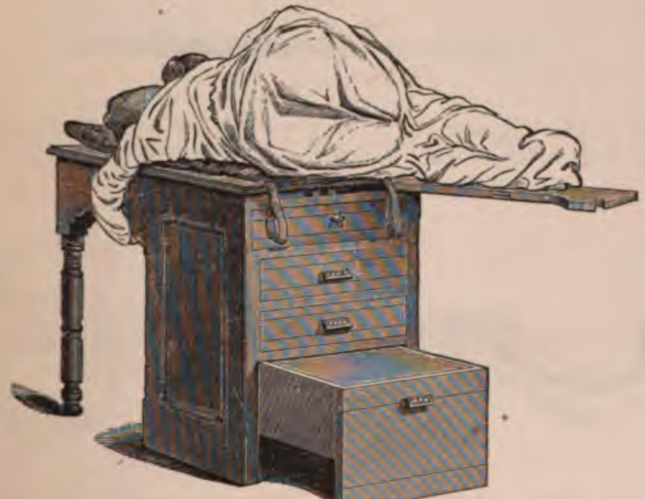
This instrument may be made stationary, and thus enable the operator both to expose the interior of the vagina and apply remedies. It consists of the following parts, arranged for use thus: A brass clamp is attached to the edge of the table on the left-hand side of the operator; in this clamp is fastened a steel rod ten inches long; a brass slide moves freely up and down the rod and also revolves upon it, being made fast at any point by a screw; in the upper part of this slide is a second screw passing through a slot in the arm; the arm is also of brass and terminates in a curve or hook, against which rests the speculum blade not in use.

Fig. 797.



Single valve speculum.

Fig. 798.

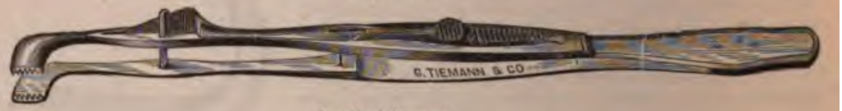


Gynecological table.

In the practice of gynecology a table properly arranged, with convenient drawers for instruments, is an excellent substitute for the unsightly, often ill-adapted and expensive chairs that are commonly used. The patient is easily and comfortably placed in the semi-prone position (Fig. 798), or on the back, while every needed appliance is at hand.

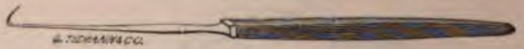
Vesico-vaginal fistula,[1] following parturition, is an opening due to sloughing into the bladder, resulting from delay in delivery after impaction has taken place. The only remedy is closure by suture. The secret of success in this operation lies in a course of preparatory treatment by which the hypertrophied and indurated edges of the fistula have recovered a natural color and healthiness. The course of treatment may require many weeks. First, the deposits upon the surfaces of the fistula must be removed by means of a soft sponge; then the raw surface must be brushed over with a weak solution of nitrate of silver about every fifth day; copious warm water injections to the vagina must be used several times daily; and warm sitz baths are useful. The patient being in proper condition, place her on the table (Fig. 798), on her left side, the knees flexed on the abdomen, the body well rolled over on the chest, the left arm turned out over the table, and the head elevated as little as possible. Having decided on the direction for closing the fistula, scarify its edges by seizing with a tenaculum (Fig. 800) or forceps (Fig. 799) the most depending point, and with scissors of proper curve (Fig. 801) remove the inner edge in a continuous strip.

Fig. 799.



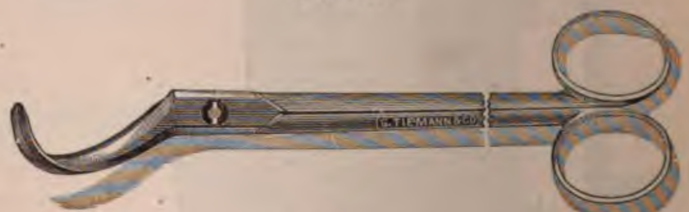
Toothed forceps.

Fig. 800.



Tenaculum.

Fig. 801.



Curved scissors.

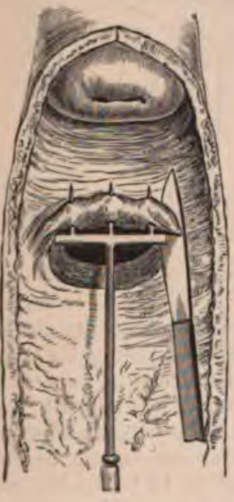
---

[1] J. M. Sims.

It requires but little practice to make this, in most cases, continuous around the entire fistula to the starting-point; if the denuded portion is not of sufficient width more should be removed; just outside of it the scarification should extend as near the mucous membrane of the bladder as possible without involving it.[1] A pronged guide[2] has been found useful in paring fistula high up in the vagina (Fig. 802).

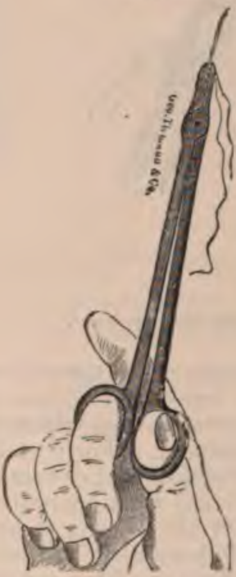
The best method of securing the edges of the fistula is by the simple interrupted suture. The needle should be armed with a short silk loop, tied with a half knot at the eye, and the wire should be attached.

Fig. 802.



Paring edges of vaginal fistula.

Fig. 803.



Needle forceps.

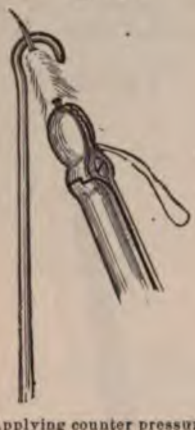
The needles should be from one-half to three-quarters of an inch in length, round, with a slight curve near the point, thickest at the eye and countersunk to receive the thread; this needle makes a punctured wound which the wire perfectly fills. The needle should be inserted with suitable forceps (Fig. 803).[3]

The point of the tenaculum should be introduced towards the fistula at a convenient distance from its vaginal edge, then by a rotation of the hand in the opposite direction the bladder edge of the fistula will be turned out; introduce the needle, held in the forceps, behind the tenaculum, bringing its point out just at the bladder surface, and while still grasping it with the forceps withdraw the tenaculum, pass its hook over the point of the needle to make counter pressure, while it is advanced as far as the forceps will allow (Fig. 804); then seize the exposed portion of the needle and draw it entirely through; seize the edge on the opposite side with the tenaculum in the same manner, and introduce the needle at a corresponding point near the bladder surface. Draw the suture through with the feeder (Fig. 805) to avoid the cutting of the thread if traction was made at an acute angle. As a rule, four or five sutures should be applied to the inch (Fig. 806), and one or more should be passed at each extremity. As each suture is introduced, follow it at once with the wire, for the silk soon becomes weakened after being saturated with the blood and urine. It is generally most convenient to secure first the suture nearest the outlet of the vagina; make sufficient traction to bring the edges of the fistula together, and cut off the excess of wire (Fig. 807); introduce the loop within the slit of the shield (Fig. 808), and, with the twisting forceps (Fig. 809), twist the loop until the edges of the wound are approximated, but not strangulated (Fig. 810). Each end of the suture must be bent on itself flat to the vaginal surface at the point of exit, and again at a right angle just over the surface to be

---

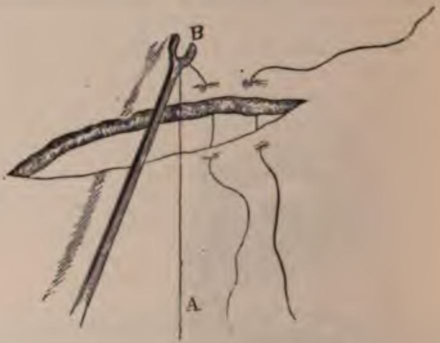
[1] T. G. Thomas. [2] T. Bryant. [3] J. M. Sims.

Fig. 804.



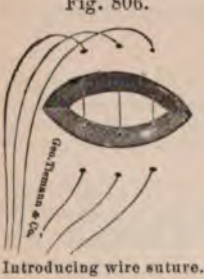
Applying counter pressure.

Fig. 805.



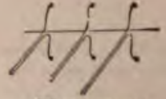
Using the feeder in introducing sutures.

Fig. 806.



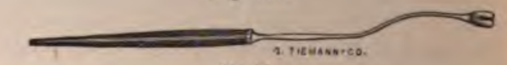
Introducing wire suture.

Fig. 807.



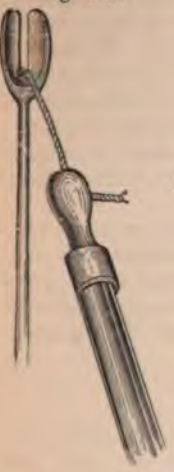
Wires cut off.

Fig. 808.



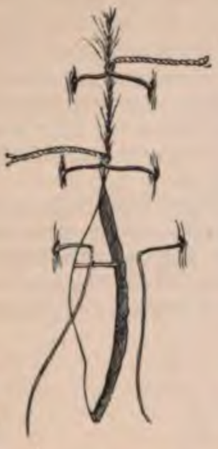
Shield.

Fig. 809.



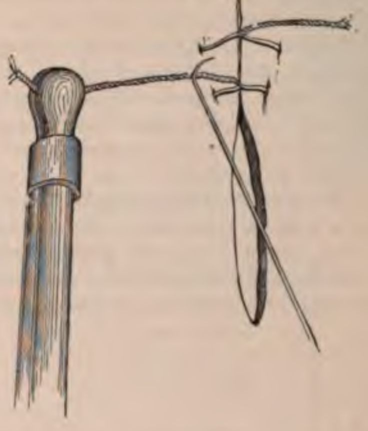
Twisting a suture.[1]

Fig. 810.



Shouldering sutures.[1]

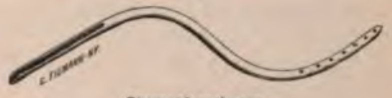
Fig. 811.



Flattening the sutures to the vaginal surface.[1]

united. Cut each suture with scissors half an inch from the wound, and turn the ends flatwise by drawing them over the hook (Fig. 811). The sigmoid catheter (Fig. 812) is now introduced into the bladder, and rests upon the back, secured with quiet; the vagina must be syringed with soaped-water, daily, and simple diet enforced; the sutures should be removed about the tenth day.

Fig. 812.



Sigmoid catheter.

Vaginismus is an excessive hyperæsthesia of the vulvar outlet, associated with such involuntary spasmodic contraction of the sphincter vaginæ as to prevent coition; violent spasmodic action is produced by the gentlest touch, as of a camel's-hair pencil or fine feather; though all parts of the vaginal outlet are sensitive, it is greatest at the fourchette where the hymen projects upwards. It may be associated with and depend upon inflammation and thickening of the hymen, excoriations, fissures, neuromata, caruncle of the meatus. The general treatment must aim to remove all conditions which are found to cause or aggravate the spasm.

Secure complete sexual abstinence, and for three or four days direct a tepid sitz bath, night and morning; warm local bathing, with lead-water; freedom from friction by motion; then apply arg. nit. 10 to 20 grs. to ℥j of water to the parts; after eight days of this treatment, insert vaginal suppositories of ext. belladonna and cocoa-butter behind the hymen, daily, for two or three weeks; then commence dilatation with graduated glass specula, allowing them to remain from one-half to one hour, and increasing their frequency.[2] Other useful applications are iodoform;[3] ointments containing atropine, 2 grs. to an ounce of lard.[4] If these remedies are not successful, operative measures are necessary.

---

[1] T. A. Emmet. [2] Scanzoni. [3] Tarnier. [4] E. A. Peaslee.

Forcible dilatation may first be employed:[1] Give an anæsthetic, and proceed to distend the ostium vaginæ with the thumbs, in the same manner as the sphincter ani is dilated (Fig. 534). Or, use the trivalve or quadrivalve speculum for distension.[2] If spasm persist, give an anæsthetic and excise the remains of the hymen with scissors, and incise the perineal body exactly as it is torn in parturition; introduce the dilating speculum or plug, and wear it for a week, changing it daily for cleanliness; then employ copious vaginal injections of warm water, twice daily.

Tumors of the vagina, solid and non-malignant, are rare; they are usually fibroids or fibro-myomata, rarely pure sarcomata; they may spring from any part of the vagina, appear at any age, grow slowly and without inconvenience. Their removal is attended with hemorrhage, and hence the galvano-caustic, or écraseur, is required.

CHAPTER LXI.

THE VULVA.

The vulva is a general term which includes all the external parts of the generative organs of the female.[3]

Adhesion of the labia,[4] the most common deformity met with, exists when the parts adhere together just at the nymphæ, or in front of them, close to the meatus urethræ; it appears as a grayish-looking septum, usually complete. The treatment should be immediate rupture, for if the membrane be allowed to remain it may become thicker and require dissection; after rupture all the parts must be maintained well opened.

Imperforate hymen[5] may be recognized in the child, but generally it is not discovered until puberty. It appears as a membrane stretched across a well-formed vagina, within an inch or two of the labia, and more or less thick and unyielding. An effort should always be made to determine its thickness; and also whether the uterus is present, by examining as to the amount of space between the bladder and rectum;[6] if the space is slight, there is reason to believe that there is no uterus, and the operation may be deferred. But an early operation is much safer than one undertaken after menstruation has begun, and should be performed, if necessary. In children, the membrane may be readily ruptured; but at puberty the operation is attended by much danger to life.

In a very considerable proportion of cases, fatal peritonitis ensues in a few days, due, apparently, to the escape of menstrual fluid through the Fallopian tubes.[7]

---

[1] E. J. Tilt,
[2] T. G. Thomas.
[3] Quain's Anat.
[4] T. Holmes; A. Johnson.
[5] J. Hutchinson.
[6] T. Holmes.
[7] Bernutz.

Operate thus: Place the patient on the back, with the thighs flexed; the exact position of the centre of the vagina above being made out, direct the patient to force down; when the occluding structure is distended, introduce a bistoury into its centre and enlarge the opening so as to admit the finger which will act as a director in making free crucial incisions; if there is a redundancy of membrane dissect away part of it; care must be taken, for a week or two, to prevent contraction.

Thrombus, blood-clot, resulting from injury, forms in the labia; in time it undergoes softening, and an abscess results. The early treatment should be cold, but when suppuration occurs poultices must be applied, and the abscess opened when fully formed.

Hypertrophies of the labia commence usually in inflammatory œdema produced by the irritation of gonorrhœal discharge or mucous tubercle; they consist only of hypertrophied cutaneous tissue, and when large increase in consequence of the mechanical impediments to the circulation. They should be removed early, and, owing to the tendency to excessive hemorrhage, the base should be transfixed by harelip pins with twisted ligatures, after all bleeding vessels have been ligated.

Epithelioma[1] is the chief form of malignant disease of these parts; it appears as an irregular, undermined, indurated edge, an unhealthy gray surface, and a tendency to the production of warty granulations; the prognosis is very unfavorable, owing to the tendency to rapid absorption. Removal by the knife or caustics is the only remedy.

Laceration of the vulva and perineum occurs during the last act of labor, and may be due to (1) anatomical conformations, as a too straight sacrum, a too sharp curve forward of the vagina, extreme smallness of vulva; (2) excessive size of the head of the child; (3) peculiarities of labor, as face presentations, incomplete or excessive flexion, too rapid or too slow.[2] The extent of laceration may vary from a slight fissure to complete division of the perineum and sphincter ani.[3]

By laceration of the perineum the ischio-perineal ligaments are divided, and then the transverse perinei muscles and other attachments draw the sides of the vaginal outlet apart; the connective tissue of the pelvis can therefore no longer exercise the same sustaining power, nor that little in the same direction as heretofore, so that the canal now remains patulous; there remains no support to the uterus while the woman is in the upright position, except through the connective tissue and the utero-sacral ligaments; as she stands erect, in this condition, a perpendicular line, from the front of the sphincter ani, would pass through the posterior lip of the uterus, or even behind it; the uterus is thus suspended over a constantly dilated and relaxed cavity, and with this state of things, before a very long period, complete prolapse of the uterus will take place.[4] In the normal relation of parts, it is seen that the perineum and recto-vesical septum sustain the uterus with great firmness.

---

[1] J. Hutchinson. [2] B. F. Barker. [3] I. B. Brown. [4] T. A. Emmet.

The laceration may even involve only the vaginal surface without extending through to the skin, and this is done by splitting through a fold of vaginal tissue which may be found in advance of the child's head just before birth; this lesion seems to extend deep enough to divide the central attachment of the ischio-perineal ligaments, with the effect of leaving the vaginal outlet flaccid and depriving it of its proper support. The importance of having the perineum intact, and its influence on the healthy condition of the nervous system, are not fully appreciated; when extensively lacerated, and prolapse occurs, it is easy to recognize an obvious cause of suffering; but cases are met with complicated by nervous disturbances, due to the existence of this lesion, without prolapse; this condition will sometimes be accompanied by a general irritability which cannot be traced to any other local cause, and is only relieved by restoring the perineum; there are instances in which the existence of even a scar on the perineum excited so much reflex irritation as entirely to change the disposition of the woman, and yet she was not conscious of any local difficulty.[1]

Whenever the perineum has been lacerated so that the proper degree of support to the vaginal walls is no longer exerted, there can be no doubt as to the necessity for an operation to restore the parts to their original condition; there are cases, however, where a doubt may remain even after a careful examination; but if, after the occurrence of the accident, the vagina becomes a patulous canal, so that the air enters and is displaced from the passage with every movement of the body, the operation is required.[1]

It is yet a mooted question, how soon after the injury the operation should be performed; but when the laceration has extended through the sphincter, the parts should be brought together immediately after delivery, in every instance when it is possible to do so.[1]

It is true that the lochial discharge is poisonous to a healing surface, yet a large number of these operations would be successful with a little additional care; the operation would be comparatively a simple one, and it would be unnecessary to pass the suture behind the muscle; something would be gained in every case, and support would be given to the uterus, for a while at least, until it had become somewhat reduced in size, and time gained for the overstretched vaginal tissues to recover in part their tone; a week even thus gained, in giving a proper support to the parts, may be the means of saving the patient from the necessity of undergoing treatment for months; this she may be spared, even if the operation itself should fail; if the condition of the patient, after delivery, is too critical to admit of the additional operation for bringing together the edges of an extensive laceration through the septum, it is advisable to introduce the deep perineal sutures, to include as much of the septum beyond the muscle as is possible; these sutures can be rapidly introduced, and without any special care beyond including a liberal amount of tissue; if a union of the perineum is thus gained, with a portion of the septum beyond the sphincter, but a small recto-vaginal fistula will remain; this may prove a discomfort, but its closure may be safely deferred; this little opening may be closed by dividing the perineum and sphincter ani by means of a pair of scissors, which permits the edges of the opening to be thoroughly denuded, a procedure otherwise very difficult; the parts can then be brought together and treated in every respect as if it were a case of laceration in which the surfaces had just been freshened.[1] Or, the opening may be closed after denuding the edges, by passing the sutures around the fistula from the perineum; with the finger in the rectum as a guide, a suture is passed so as to close the edge on the rectal side, and another above for the vaginal border; the lower suture includes so much of the sphincter ani muscle, that its action in the upper part is controlled; by this means the fistula closes, a result which is almost impossible to be obtained under ordinary circumstances, since the outer fibres of the muscle form one side of the fistulous opening.[1]

---

[1] T. A. Emmet.

When an operation cannot be resorted to immediately after the injury, the knees should be kept tied together, the urine properly drawn, and the greatest care given, by cleanliness, to free the parts from irritation; at the reception of the injury, the rent through the septum is more extensive than after the edges have cicatrized; therefore, if proper care be taken, by frequent injections of tepid water, to keep the parts free from irritating discharges, the edges will unite to within a short distance of the sphincter; before the patient is allowed to assume the upright position, some mechanical support must be resorted to for the purpose of lifting the uterus from the floor of the pelvis, and also to keep the organ partially anteverted, so that there may be no prolapse of the vaginal walls; after she has recovered her strength, if the child has been still-born, the operation should be performed without further delay; for the welfare of the child, if she be nursing, the operation should be deferred until it is old enough to be weaned with safety; but, at the same time, we must take into consideration the condition of the mother, as to how long she may be safely subjected to the delay, with the uterus well supported.[1]

If the sphincter ani is not involved, proceed as follows:[1] Place the patient on a narrow table, and administer the anæsthetic; now flex both legs on the abdomen, to be thus held by an assistant after the body of the patient has been drawn down to the edge of the table; in separating the labia, the fingers of one assistant must be placed directly opposite those of the other; this is necessary, for if not on the same line, or if unequal traction be made, it would be difficult to avoid denuding the side of one labium higher than that of the other. Commence the operation by removing the mucous membrane at the most dependent portion, and advance from below upwards, and thus avoid the flow of blood over the surface to be removed.

The mucous membrane is caught up on the point of a tenaculum, and with a pair of properly curved scissors it should be removed in a horizontal strip running from side to side; if the operator is ambidextrous, the whole surface may be removed in one continuous strip; by using a pair of scissors with a different curve to turn the point at one labium, we can extend the line back again upon the posterior wall of the vagina, and from there to the opposite labium, and then going over the same course again just above the preceding one.

Fig. 813.

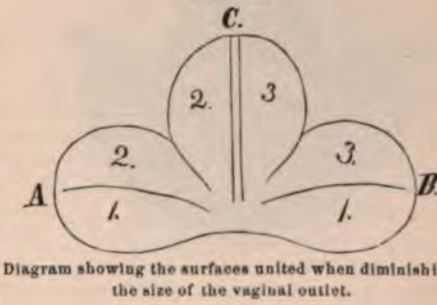


Diagram showing the surfaces united when diminishing the size of the vaginal outlet.

---

[1] T. A. Emmet.

Fig. 814.

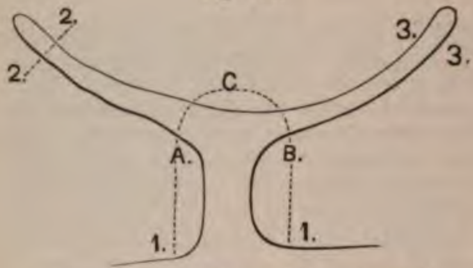
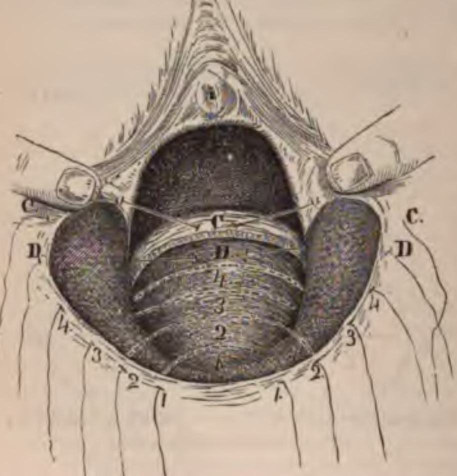


Diagram showing the direction of the sutures.

Determine the extent to which the denudation is to be carried on the posterior wall, and mark it by removing, as a guide, a small portion of tissue from the median line; the advantage of the scissors in this operation cannot be questioned, for with the utmost dexterity and quickness, the parts cannot be freshened and brought together without a great loss of blood, and the amount of bleeding is less from the use of scissors, and with them the parts can be denuded in a much shorter time than with the knife.

The outline of the denudation may be compared to the figure of a trefoil (Fig. 813); the cusps *A* and *B* represent the freshened surfaces of the labia; 1, 1 represent the external portions of the labial cusps, and 2, 3 respectively their internal or vaginal portions; the cusp *C* represents the freshened surface of the recto-vaginal septum, and is numbered in two portions 2 and 3. When the parts are drawn together (Fig. 814) portions, 1, 1, of the labial cusps lie in apposition, and portions, 2 and 3, of the labial cusps are applied to the corresponding portions, 2 and 3, of the vaginal cusps. *A*, *B*, and *C* are the points brought together; the figures 1, 1, 2, 2, and 3, 3 correspond to the same given in the preceding diagram.

Fig. 815.



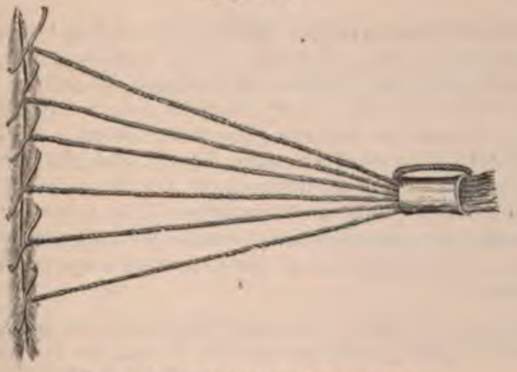
Emmet's operation for diminishing the vaginal outlet by external sutures.

Use a thick, straight sewing needle, from an inch and a half to two inches in length, with a large eye for introducing the silk loop, to which the wire is to be afterwards attached before being drawn through; the index-finger must be passed into the rectum to appreciate the course and facilitate the passage of the needle, and, at the same time, it will protect the posterior wall of the bowel from becoming transfixed; as the tissues of the recto-vaginal septum are thus lifted up on the point of the finger the course to be followed by the needle becomes nearly straight. The central letter *C* (Fig. 815) is at the crest of the rectocele; the surface has been denuded from the edge of the sphincter ani muscle up each labium to the remains of the carunculæ, and across on the posterior wall of the vagina to the extent of the rectocele. Introduce the first suture nearest to the edge of the anus, and its course through the recto-vaginal septum is indicated by the dotted line. The same explanation in regard to their course is applicable to the other numbered sutures.

The course of the suture *D* is shown on its exit, from behind one labium, to enter at *D* on the upper edge of the denuded surface over the posterior wall of the vagina. This is essentially the last suture introduced to secure this surface, and does not include more than an inch before it passes to the opposite labium. The course of the uppermost suture, *C*, is through the labium, just in line with the limit of the freshened surface. It is then made to catch up a small portion of the vaginal tissue at *C*, beyond the denuded surface on the recto-vaginal wall, when it also passes to the opposite labium.

Leave each twisted suture about three inches in length, and when the operation has been completed, secure the ends of all of these together, like the radii of an open fan; these ends may be bound together by slipping over them a short section of rubber-tubing (Fig. 816). The patient must be kept in bed with her knees tied together and a soft pad between them; the urine should be drawn with care, to prevent it from running over the healing surfaces; this can best be done by flexing the legs over the abdomen, as at the time of the operation, but without removing the bandage from the knees; then, with a strip of soft cloth covering the index-finger of the left hand, the parts may be protected by placing this beneath the urethra as the catheter is withdrawn. The additional precaution should also be taken to close the end of the instrument by keeping the finger over it. Should the urethra become irritable, or circumstances occur in which the catheter cannot be employed, it will be necessary to observe more than the usual cleanliness; after the bladder has been emptied, and before removing the bed-pan, the nurse must throw a pint or more of tepid water into the vagina. The nozzle of the syringe should be carefully introduced close to the urethra, and during the

Fig. 816.



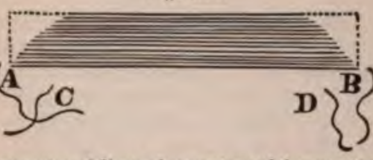
Method of securing the ends of the sutures.

administration of the injection it is to be held in this position so as not to come in contact with the line of union. Opium should not be used in any form, unless the necessity be very great, and even then it is well to seek some substitute for it. The position of the patient may be changed from the back to either side without injury to the sutures, so long as the limbs are kept together.

The parts will have become sufficiently healed by the seventh day for the removal of the sutures; no advantage is to be gained by leaving them for a longer time, but, on the contrary, there will be risk from inflammation following some accidental injury; to remove the sutures, it will be necessary to place the patient on a table, and on her back, with the feet drawn up; as it would not be advisable to separate the parts to bring the loops into view, it will be necessary to trust somewhat to the sense of touch; first remove the piece of tubing by cutting through the mass of sutures, which will free them all; then the lowest one may be grasped by a pair of forceps and gently turned to the right side, while the blades of a pair of sharp-pointed scissors are passed down along the left side of the suture in search of the loop. The parts can be supported and also protected by an assistant pressing or holding the labia together until all the sutures have been withdrawn. For a week after the removal of the sutures, the limbs should remain bound together, then the bandage may be thrown aside, and only used at night for a short time longer. It should be the rule that the patient be not allowed to assume the upright position for two weeks.[1]

Laceration through the sphincter ani[1] is but an extension of the laceration of the perineum. It is, however, without any necessary bearing on the question of prolapse, as advice is generally sought for early, and the injury repaired before sufficient time has elapsed for the case to become thus complicated. Both conditions are but different degrees of the same injury, and the same operation also, varying only in detail, is required for the relief of both. The necessary dissection of the surfaces about to be united must be made as before, and when completed the wound will appear as represented (Fig. 818).[2] The explanation of the necessary steps of this operation is as follows:—[1]

Fig. 817.



Retraction of fibres after rupture of the muscles.

When the perineum and the muscular ring forming the sphincter ani have been lacerated, a gaping triangular opening is left; the base of this opening would be formed by the lacerated muscle and the apex by the limit of the laceration through the recto-vaginal septum; gradually the fibres which formed the inner surface of the circle, when the muscle was in its integrity, will have shortened more than those on the outer margin which remain attached to the neighboring tissues; the diagram (Fig. 817) shows the corners rounded off, and the muscular fibre under the mucous membrane of the rectum contracted more than any other portion; a convex surface is presented by the shortening of the inner fibres from the dotted outline, representing a parallelogram, which was the original shape of the muscle just after it was ruptured. After the edges of the muscle have been properly freshened, the most important step in the operation will be the manner of introducing the first suture, in its relation to the edges of the divided muscle. If the first suture be entered on the line a little outside of A B (Fig. 817), and at the point which would seem the most appropriate, but a small portion of the muscle could be approximated. Fig. 819 exhibits the condition of the parts, when they have been thus secured by a suture entered from A B, with incontinence as the consequence. Introduce, however, the suture at some distance behind the edge of the muscle, as the points C D (Fig. 817), and a different result will be obtained; a glance at Fig. 820 will show that, on securing the sutures, the divided edges of the sphincter will be turned up and brought in perfect apposition. When the suture is passed from behind the edges of the muscle and around the laceration, in the recto-vaginal septum, the edges of the muscle must be turned up on tightening.

---

[1] T. A. Emmet.

[2] G. G. Bantock.

Fig. 818.

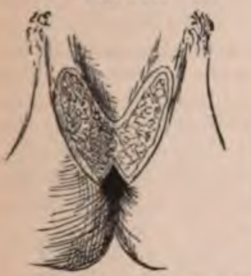


Fig. 819.

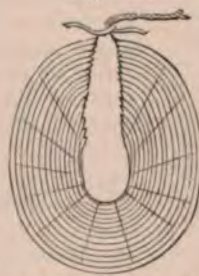


Fig. 820.

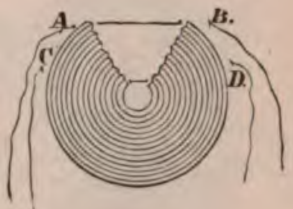


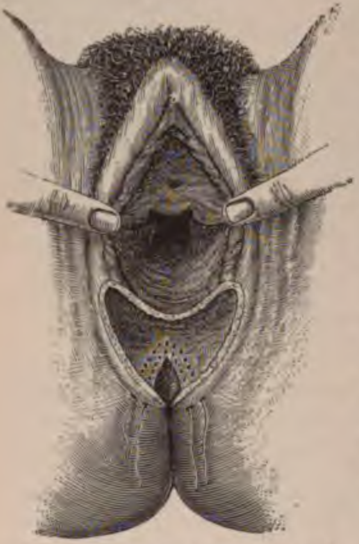
Fig. 818.—Parts dissected.
Fig. 819.—Diagram showing faulty introduction of sutures.
Fig. 820.—Diagram showing proper introduction of sutures.

The necessary position of the patient for the operation, with all other details, is essentially the same as described for closing a laceration of the perineum. The surfaces which have been lacerated, and are again to be freshened, are generally well mapped out by a slight cicatricial glaze. Under ordinary circumstances, unless sloughing has occurred, there can be but little difficulty in determining the extent. As the edges of the laceration through the septum have to be freshened with care, it is essential to commence the denuding from the most depending point, and by this means escape the annoyance of blood flowing over the parts.

If we examine carefully the extremities of the lacerated muscle, we shall find a slight pit or depression at each end, which has been caused by the contraction of a portion of its fibres. It is necessary to freshen these surfaces, for by so doing we denude the ends of the muscle along the spaces between the dotted angles, shown in Fig. 817. At the commencement of the operation a portion of the tissues at one of these points must be seized with a tenaculum and with a pair of scissors removed, together with a narrow strip entirely around the laceration to the opposite end of the muscle. This strip must be removed as close to the edge of the rectal mucous membrane as can be done without wounding it. Whenever the edges of the laceration in the recto-vaginal septum are found terminating in a thin bevelled edge, it will be necessary to gain the needed width by removing a sufficient portion of the vaginal mucous membrane.

The needle is to be introduced behind the edge of the muscle to the left, at the point D, Fig. 817. It is then made to sweep around the angle of the laceration in the septum to the point of exit at C, and this is done by gradually rotating the forceps with a movement of the wrist. As in laceration of the perineum, it is necessary that the index finger of the left hand be introduced into the rectum to serve as a guide. As the point of the needle punctures the skin in its exit, the finger may be withdrawn from the rectum to aid the passage of the needle. This can be done by the counter pressure of a blunt hook, or by sliding back the tissues sufficiently with the fingers, for the needle to be seized by the forceps and drawn through. The second suture is to be introduced just outside of the end of the muscle, and in the same plane with the divided rectal edge of the laceration. The third suture is to secure the vaginal edge of the laceration. It should be made to include the tissues liberally, and to sweep around the angle of the laceration at some distance beyond the course of the first and second suture; this is necessary, since this suture is the one most liable to cut through the recto-vaginal septum and leave a fistula. The other sutures are to be introduced as in a case of simple laceration of the perineum (Fig. 821). It is necessary to secure first the lowest suture, C D (Fig. 817). This is done by seizing the ends of the wire at a proper distance, so that the fingers may be used to slide the tissues firmly down on the suture, as moderate traction on the wire is made at the same time with the hands. The suture is then secured, without relaxing the traction, by several half turns made on reversing the position of the hands from one side to the other. Each suture is thus in turn secured from below upward. The parts should be just brought in apposition, and no more, for in a few hours there will be sufficient swelling to force the tissues in close contact. The after-treatment is the same as that given above.

Fig. 821.



Complete perineal rupture. First and second sutures in place.

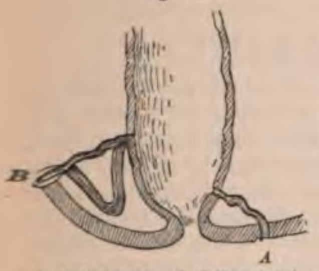
Recto-labial and vulvar fistulæ[1] are believed to arise from glands[2] situated in the lateral and posterior part of the vulva, near the entrance of the vagina. These glands may become inflamed, together with the surrounding connective tissue, and an abscess forms; this abscess, before opening outward, may also penetrate backwards along the rectum and vagina, and finally open into the former two or three inches above the anus. Subsequently the abscess opens externally, and thus a true recto-labial or vulvar fistula is formed (Fig. 822). The labial or vulvar orifice of the sinus may be where the orifice of the duct of the gland is located, or it may be midway and in some

[1] I. E. Taylor.

[2] Bartholinus.

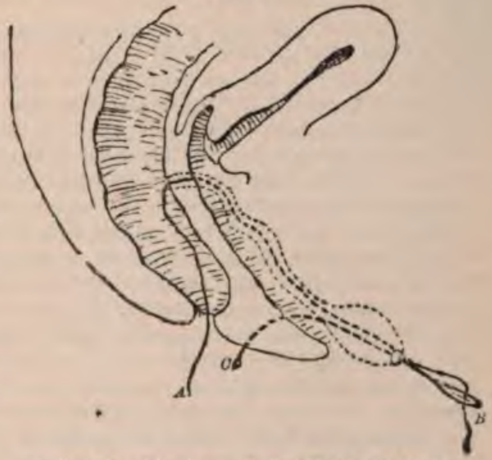
instances as high as the urethra, the size of the orifice in the labia is generally very small, and so minute in some cases as to require half an hour or more to discover it, and then the orifice will admit only the smallest probe; at times there is a valvular opening. The pathognomonic symptoms are the escape of air, gas, or very liquid fecal matter. The treatment consists in opening a new route externally, and using the ligature as follows: Enter a probe at the external orifice and pass it down to a point just outside of the sphincter ani (Fig. 823); cut open the end, then withdraw it and pass a more slender and ductile one up to the rectal opening through the sinus, having the eye threaded with an elastic ligature; with the finger in the rectum recognize the probe, curve it, and draw it down through

Fig 822.



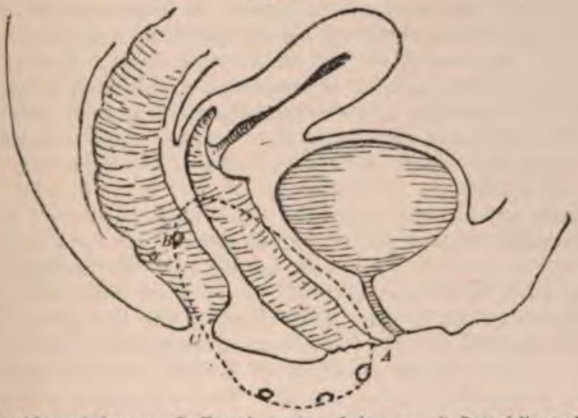
A. Anal fistula. *B.* Labio-rectal fistula.

Fig. 823.



A. End of anal ligature. *B.* End of labial ligature. *C.* Perineal ligature, as passed.

Fig. 824.



A. Labial orifices of abscess. *B.* Rectal opening of abscess. *C.* Dotted lines of abscess.

the rectum and anus, bringing the ligature out at the anus (Fig. 824). The ligature is then tied, shotted, and clamped, and the ends clipped off. The elastic ligature cuts its way through the intervening tissues in a few days, and the sinus with its openings is permanently closed.

VULVAR AND VAGINAL ENTEROCELE.[1]

The following varieties of hernia may show themselves in the vagina and vulva: 1. Vaginal enterocele, or descent of a portion of the small intestines into the vagina. 2. Pudendal enterocele, pudendal hernia, or descent of the small intestines into the labium majus of one or both sides; and 3. Perineal enterocele, perineal hernia, or descent of the small intestines by protrusion through the perineum.

Vaginal enterocele consists in a descent of the intestines into the pelvic cavity, either in front of or posterior to the broad ligament of one side; they always descend a little obliquely, and most frequently posteriorly; usually the intestines alone descend, but sometimes the omentum accompanies them; generally the small intestines form the hernial protrusion.

Vaginal hernia, as a rule, develops itself in the following manner: a loop of intestine gradually pushes downward the prolongation of the peritoneum which forms the pouch of Douglas until it impinges upon the outside of the wall of the vagina and causes it to arch inward; this mechanical influence being continued and gradually increased, a tumor forms in the vaginal canal, inverts one wall of that canal more and more completely, and may end by escaping from the vulva and hanging outside the body, similar to a complete prolapse of the bladder or of the uterus. The tumor has for its component parts, first, the inverted vaginal wall; second, the peritoneum; and, third, the intestines.

The greatest danger which attends this form of hernia arises from the possibility of an error of diagnosis; the tumor occurring during labor and obstructing the progress of the fœtal head, the conclusion may be that an ovarian or parovarian cyst with a long pedicle has been pushed into the pelvis; a trocar and canula may be plunged in, followed by the escape of fecal matter and intestinal gases. Or, if the condition be found to exist in the non-parturient woman, an effort may be made to remove it, and, as this effort advances, the error becomes apparent.

The most frequent cause for this hernia is parturition. As long as vaginal hernia remains in the pelvic cavity and does not interfere with parturition, it is usually a matter of little moment and the source of little inconvenience. Under certain influences, however, occurring during parturition, as well as in the non-parturient state, such as pressure from the fœtal head, inflammatory processes, fecal impaction, torsion of the contents of the sac, or the existence of a neoplasm, strangulation may occur. The symptoms which are apt to develop are difficulty in locomotion, pelvic tenesmus, or bearing down, colicky pains, dragging sensations, tendency to constipation, and, in time, vomiting. Should the accident complicate parturition, obstructed labor is apt to result. Upon vaginal examination, a tumor of greater or less size is found in the vagina, and is diagnosticated by the following physical signs: It is supple, soft, and yielding; decreases upon pressure; gives a sense of gurgling to the finger if not to the ear; increases upon the patient's coughing or straining; yields resonance upon percussion, and is very generally reducible if the patient be placed in the knee-chest position and efficient taxis be practised. Vaginal enterocele may be confounded with the following conditions by a careless and rapid diagnostician: Prolapse of vagina, uterus, bladder, or rectum, or a combination of these displacements; with vaginal cyst, parovarian, or ovarian cyst; with a fibrous tumor presenting low down in the pelvis; with a cold abscess of the pelvis; or with a marked case of tubal dropsy.

---

[1] T. G. Thomas.

Pudendal hernia[1] appears as an elastic tumor, about as large as a small hen's egg, near the middle of the labium majus of one side. It may originate in two ways: 1. The round ligaments of the female, after passing down through the inguinal canals, lose themselves in two glove-finger prolongations of fibrous character, which run down through the labia majora; following the course of these ligaments through the abdominal rings and the inguinal canal the intestines sometimes descend, as they do along the spermatic cord in getting to the scrotum, and reach their ultimate point of descent in these dartoid sacs. 2. They sometimes reach the pudendum by passing downward between the vagina and the ramus of the ischium, thus reaching the labium majus from within the pelvis; in its commencement the latter variety resembles exactly vaginal hernia; but, instead of inverting the vagina before it as that does, it separates the vaginal wall from the ischium and insinuates itself between these parts. From inguinal hernia ending by descent into the labium majus the internal variety may be thus distinguished: (1) the finger, pushing the tumor upward, will pass into the pelvic cavity between the ischium and vagina; (2) at the level of the os uteri, or thereabouts, it will enter the pelvic roof; and (3) pressure being maintained on the inguinal canal, and the patient being ordered to cough, it will, in spite of the pressure, recur. The diagnostic signs which prove most reliable, and which may almost be styled pathognomonic, are these: First, airy feeling upon palpation; second, gurgling upon replacement; third, diminished tension in the dorsal decubitus; fourth, diminution of bulk upon taxis; fifth, resonance upon percussion; sixth, succussion upon coughing; and, seventh, intestinal pains of a colicky character.

Perineal hernia[1] may affect both male and female. In the latter it consists of the descent of the intestines between the vagina and rectum, the advance being made posterior to the broad ligament, and continuing until the perineal muscles are forced apart, and the gut, with its peritoneal envelope, is arrested by the skin.

> The hernial sac protrudes as far as the skin of the perineum, but does not project it so as to form an external tumor; its existence in the male can be only ascertained during life by an examination by the rectum; but in the female it may be felt both by the rectum and by the vagina. The sac lies between these two canals.[2]

---

[1] T. G. Thomas.

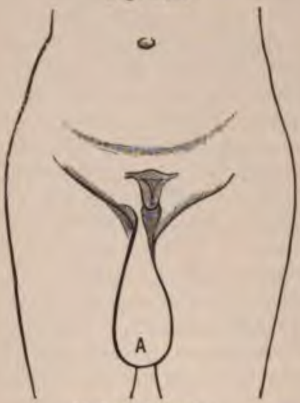
[2] Sir A. Cooper.

Unfortunately little can be said concerning the treatment of vaginal and vulvar herniæ, for the reason that there is but one variety, the pudendal, which eventuates from inguinal hernia, for which very much can be done; that variety is as amenable to treatment by the ordinary truss as inguinal hernia is; the other varieties can, to a limited degree, be relieved by pessaries, perineal pads, abdominal bandages.

All these varieties of hernia are usually readily reduced by taxis, and this is greatly facilitated by the knee-chest, or genu-pectoral, position; in some rare cases strangulation occurs. Under these circumstances the same surgical practice is indicated as in inguinal or crural hernia—namely, cautious opening of the sac and section of the constricting band by passing up a probe-pointed bistoury.

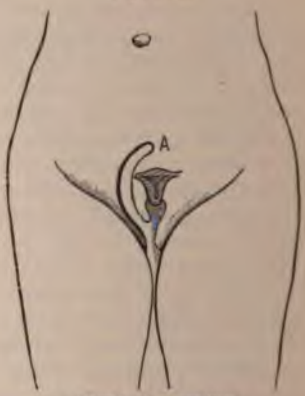
A radical cure was found to be attended with difficulties:[1] Taxis being practised in the knee-chest position, the tumor disappeared with a very slight gurgle, its contents evidently retreating into the pelvis through an opening on the right side. After the contents of the sac were returned to the abdomen it was evident that their retention there, or even the retention of the sac itself within the pelvis, would prove impossible by any mechanical contrivance which could be devised, for two reasons: first, the great weight of the mass; and, second, the fact that pressure of it against the bladder and rectum when it was returned to the body interfered so greatly with the functions of these viscera as to render the patient utterly uncomfortable. The following operation was suggested and successfully performed: Performed laparotomy; then caused an assistant to keep the hernial sac well within the pelvis by one hand in the vagina; pulled the contents out of the sac; seized this at its most dependent portion (A, Fig. 825), dragged it up into the abdominal wound, and fastened it there by suture, sustaining the heavy sac, meanwhile, by two knitting-needles

Fig. 825.



Pudendal hernia.

Fig. 826.



Result of operation.

---

[1] T. G. Thomas.

passed through and lying flat across the abdomen (Fig. 826). The patient made a good recovery, and so far, more than a month having now passed since the operation, has continued to be free from any return of the hernia.

CHAPTER LXII.

THE MAMMARY GLANDS.

THESE glands, the organs of lactation in the female, are accessory parts of the reproductive system; when fully developed, they form, with the integuments and a considerable quantity of fat, two rounded eminences, the breasts, placed on each side on the front of the thorax; the base of the gland is nearly circular, flattened, or slightly concave, its largest diameter being directed upwards and outwards; it rests upon the pectoral muscle, to which it is connected by a layer of areolar tissue.[1]

Inflammation of the breast,[2] mastitis, may occur in three forms: (1) The subcutaneous connective tissue may alone be affected; this form is often caused by bruising or irritation, as in rude attempts to use a breast pump, the symptoms and appearances being those of phlegmonous inflammation. The treatment, at first, must be painting with iodine, avoidance of rubbing, and of bruising, while nursing; aconite if the fever is high; anodynes to relieve pain; if suppuration occur, apply hot poultices, or cloths soaked in hot water and covered by oiled silk; evacuate pus, when detected, avoiding the areolæ, to prevent a cicatrix which would retract the nipple. (2) The gland structure may inflame from lacteal obstruction or engorgement; it is marked by a nodulated induration, exquisitely tender, and very painful, rendering nursing distressing; the constitutional symptoms depend upon the individual; if she is robust, the fever is high and the course of the disease rapid, but if she is feeble, the fever is less and the course chronic. The early local treatment is relief to the engorgement by gently rubbing the lump with the fingers lubricated with olive oil until the mass disappears, avoidance of nursing and the relief of the breast by artificial means, supporting the breast by a broad bandage passed under it and around the neck; ext. belladonna, well rubbed in, to relieve pain, relax tissues, and diminish the secretion of milk; if suppuration is evident, hot poultices must be applied, and the abscess opened when fluctuation is distinct; too early incision is liable to involve the milk-tubes. If the fever is high, give aconite to the robust, and saline laxatives and quinine to the more feeble; opium, as Dover or Tully powder, or the bromides, are always useful. (3) The inflammation may attack the subglandular connective tissue; the breast is greatly enlarged and heavy, but smooth, and not markedly tender; there are irregular chills and fever, with intervals of perspiration.

---

[1] Quain's Anatomy.

[2] B. F. Barker.

The treatment is avoidance of bruising, as rubbing the breast, but nursing must be continued; support of the gland by the bandage; poulticing at the point where pus is forming; evacuation of pus by puncture without wounding the gland structure; the general treatment is the same as that given in the other forms of inflammation.

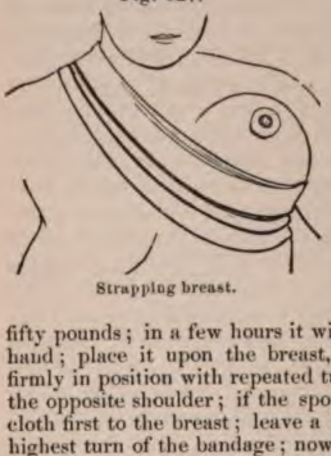
Abscess of the breast is liable to remain a chronic form after the glandular and subglandular varieties, which are sources of great annoyance and continued ill health.

Their chronicity depends upon the fact that the abscess-cavities have no direct outlet for their contents; the escape from existing sinuses is chiefly the overflow; from time to time the corrosive secretion opens new and more direct outlets, and not unfrequently a single abscess is found to have several sinuses, or cicatrices of sinuses which have healed as new openings formed.

The treatment by incision, to lay open the abscess, is unnecessarily severe, and is often followed by deep cicatrices which destroy the function of portions of the breast; systematic strapping is far more useful, for by compressing the abscess-walls so as to force out the contents and place the opposing surfaces in apposition, union often promptly follows, and the cure is complete.

The straps should be cut sufficiently long to pass from the opposite shoulder, under the breast to the point of starting, and in width about two inches; having the breast firmly raised, apply the end of the strap over the opposite shoulder, and pass it under the breast and axilla, and over the back to the place of departure, allowing the ends to overlap (Fig. 827). Each successive strap should overlap the preceding towards the nipple, until the required compression or support is attained.

Fig. 827.



Strapping breast.

A still more simple and effective method is pressure with the compressed sponge, as follows:—[1]

Select a soft sponge, larger than the breast, cup-shaped, and three or four inches in thickness when wet; wash it and place it between two boards under a weight of fifty pounds; in a few hours it will be dry and reduced to the thickness of the hand; place it upon the breast, the cup being over the nipple, and bind it firmly in position with repeated turns of the bandage around the body and over the opposite shoulder; if the sponge is too harsh, apply a layer of lint or soft cloth first to the breast; leave a small portion of sponge projecting above the highest turn of the bandage; now apply warm water to this point of the sponge and continue until the entire sponge becomes saturated under the bandages; the swelling of the sponge evacuates by the gentlest and most uniform pressure the cavity, presses the walls together, and maintains them till union takes place; the water must be reapplied as often as the sponge becomes dry; the dressings must be removed on the third day, unless the abscess has healed.

The nipple and areola[2] are liable to be affected in women forty years and upwards, with a chronic affection of the skin, which often precedes cancer of the deeper parts of the gland; it appears as a florid, intensely red, raw surface, very finely granular, as if nearly the whole thickness of the epidermis were removed, like the surface of very acute diffuse eczema, or an acute balanitis; there is always a copious, clear, yellowish, viscid exudation; the sensations are commonly tingling, itching, and burning, but the general health is unaffected. The cancerous growth has always appeared within two years, not in the skin, but deeply in the glands. The treatment by ordinary remedies has proved unavailing; removal of the breast is suggested as the more judicious procedure.

---

[1] J. P. Batchelder.

[2] Sir J. Paget.

Tumors of the breast may spring from the epithelial elements of the gland, or from its connective tissue; the former embraces simple hypertrophy, adenoma, soft and hard cancer, and the latter sarcoma, fibroma, and myxoma. Most of the tumors may develop cysts as they increase in size. The recognized treatment is removal, and the success of the operation, as well as the extent of the incision, must depend upon the nature of the growth.

Non-malignant tumors of the breast[1] more often occur in women under forty; they are covered with healthy skin, except in the ulcerated stage of the sarcomata, and the skin even then does not appear infiltrated; they are somewhat nodulated, not very hard, occasionally partially elastic, movable, and non-adherent; the nipple is rarely retracted and the superficial veins are not markedly dilated; there is seldom much pain, except in the case of the irritable tumor, and then continuous and of a neuralgic character; the neighboring lymphatic glands are not involved; there is no tendency to multiplication in internal organs, and, therefore, no cachexia; the tumor grows slowly and rarely recurs when thoroughly excised, except sarcomata, which grow rapidly and are very apt to recur.

Scirrhus[1] is seldom met with in persons under forty; it originates as a small nodule, of stony hardness, and soon becomes fixed and adherent to subjacent tissues, being evidently infiltrated among the tissues in which it is developed; the skin becomes widely involved, having a peculiar pitted or dimpled appearance, from the shortening of various subcutaneous fibres; in an extreme degree the pitting gives the whole breast a brawny or lardaceous appearance; the nipple is commonly retracted and the superficial veins dilated; the pain is severe, but not continuous, of a lancinating or electric character; the neighboring lymphatic glands, particularly those in the axilla and above the clavicle, become involved in the disease, which is often attended by a state of marked cachexia; the tumor usually grows pretty rapidly, is attended with ulceration, often of a peculiar character, and frequently recurs after apparently thorough removal.

Extirpation of the breast, in part or whole, is undertaken to remove growths. Non-malignant tumors require that the incision should be limited to the growth, and care be taken to avoid injuring portions of the gland not involved in the disease. These incisions assume various forms, according to the size and condition of the tumor, but, as a rule, the skin should not be sacrificed unless it is diseased. If the skin is involved, the incisions should be so directed as to remove the affected portion, and preserve, in good condition, the other parts of the breast[2] (Figs. 828, 829).

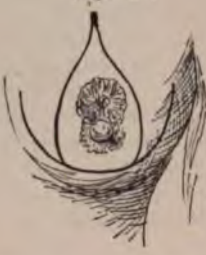
Malignant growths, on their first appearance in the breast, imperatively demand removal, for experience proves that life may thus be prolonged, a certain amount of immunity from bodily suffering and mental distress insured, and a chance of freedom from all local suffering given.[1] Removal may be effected by incision or by caustics.

---

[1] J. Ashhurst, Jr.

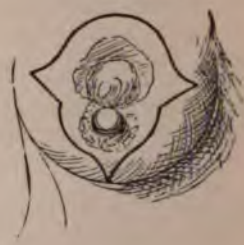
[2] P. C. Delagarde.

Fig. 828.



Axillary incision for drainage.

Fig. 829.



Incision at lowest point for drainage.

Excision of Breast.

The operation of removing the tumor, together with the breast, is always admissible when the health of the patient appears to be favorable to recovery from that operation, when the disease involves the tissues of the breast only, and when the axillary lymphatic glands are not involved.[1] It may also be undertaken with advantage when the disease has extended to the skin without infiltrating the cutaneous tissue to a wide extent, when ulceration has taken place, and even when the axillary lymphatic glands are distinctly enlarged.[1]

Four principal and vital points must be attended to:[2] 1. Remove the whole of the gland; 2, remove the nipple; 3, remove the skin widely, even when apparently healthy; 4, clean out the axilla if there be any glandular enlargements. It is the practice of many surgeons now to remove the axillary glands in all cases of cancer of the breast, whether enlarged or not, as a precautionary measure.

Operate as follows: The arm of the affected side being elevated to render the pectoral muscle tense, make the first incisions through the skin and connective tissue, in the form of an ellipse, or circle, the lower incision being first made to avoid the flow of blood; separate the attachments of the tumor from its connections on all sides; in raising the tumor from its deep connections, commence at the extremity towards the axilla, expose the pectoral muscle, and dissect downwards and forwards towards the median line until the entire mass is removed. If there are enlarged glands towards or in the axilla, extend the incision and remove them, using the handle of the scalpel to avoid wounding vessels or nerves (Fig. 830). During the dissection, control the hemorrhage by pressure with dry sponges without stopping to ligate vessels. When the tumor is removed, ligatures or torsion should be applied to all bleeding vessels; the surface should be treated with corrosive sublimate solution; then the margins of the wound should be adjusted with the continuous suture. At the axillary angle an incision should be made to admit drainage (Fig. 828), or the skin may be punctured at the lowest point and a drainage tube inserted.

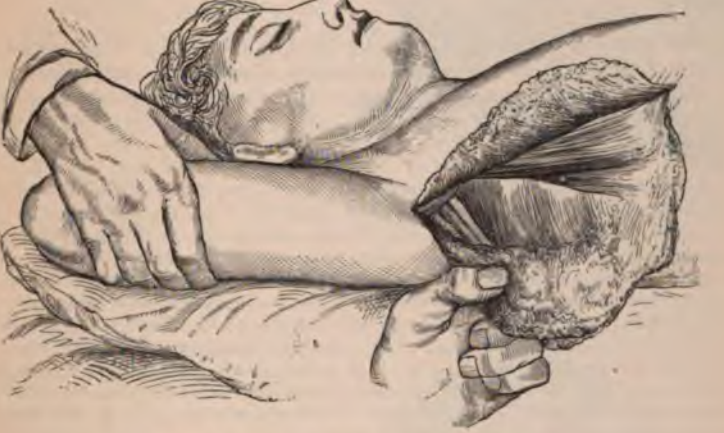
---

[1] J. Birkett.

[2] J. E. Erichsen.

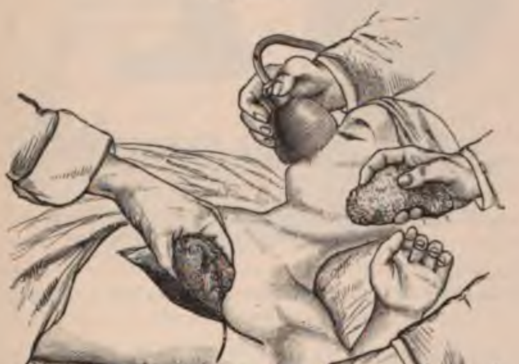
Deep canalization[1] has been successfully employed in the axillary part of the wound as follows:[2] The edges of the axillary portion of the wound were dissected up for about an inch on both sides; then the anterior skin-flap was transfixed with a stout catgut suture, and being turned well into the apex of the armpit, was sewed to the posterior aspect of the pectoralis minor muscle; the posterior flap was sutured to the latissimus dorsi. In this way the axillary cavity is transformed into a cone, lined with skin, at the apex of which a

Fig. 830.



Incisions required for thoroughly clearing axilla.[3]

Fig. 831.



Excision of the breast, with incision backward for drainage.[4]

---

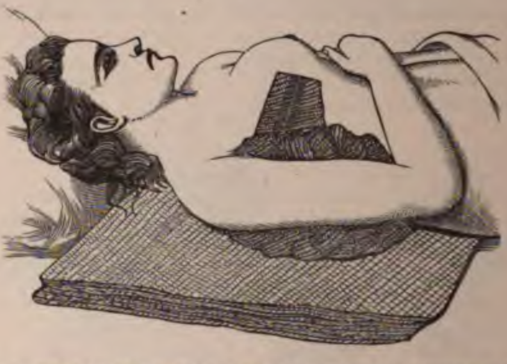
[1] Neuber. [2] Gerster. [3] J. E. Erichsen. [4] T. Bryant.

small portion of the deepest part of the axilla remains uncovered; after this, a strip of gauze, dusted with iodoform, was laid on the line of sutures, and a large pad of sublimated gauze was snugly bandaged on to the shoulder and thorax. Two weeks after operation the first dressing was removed, and the entire wound was found healed by first intention in the literal sense of the term.

The external dressings should be light and dry, the iodoform gauze or jute being preferable. It is desirable, in applying this part of the dressing, to make gentle but uniform pressure to bring the deep surfaces of the wound in accurate apposition with a view to immediate union.

No wounds admit of more thorough antiseptic dressings, and it is in excision of the breast that the value of these dressings has been most effectually demonstrated. The following are the details of Lister dressing:[1] Where the mamma and axillary glands have been removed, or for the first few days after excision of the mamma, much more ample dressings are required than those simply applied to the wound as formerly. The arm must therefore be included in the dressing. This is accomplished most conveniently in the following manner: A large dressing is applied posteriorly, reaching behind as far back as the middle line, and folding over the arm so as to touch the thorax in front, the arm being applied to the side. This dressing must be broader than the length of the upper arm from the top of the shoulder to the tip of the elbow, the overlapping parts being caught by the turns of bandage passing over the shoulder and round the body respectively. To prevent the internal condyle from suffering from the pressure, a large mass of gauze is applied behind the arm, extending downwards almost to the condyloid region, but not reaching quite so far. A mass of gauze is packed in between the arm and the side and in front, filling up the angle between the arm and the thorax (Fig. 832). A smaller anterior dressing is then applied, narrower than the posterior, reaching as far forwards as the middle line or beyond it, and outwards to the upper arm, the edge of the anterior dressing passing beneath the edge of the posterior Thus the side of the patient is completely encased in a gauze dressing. This is very easily bandaged on. One turn of bandage passes round the body outside the arm (Fig. 833,

Fig. 832.



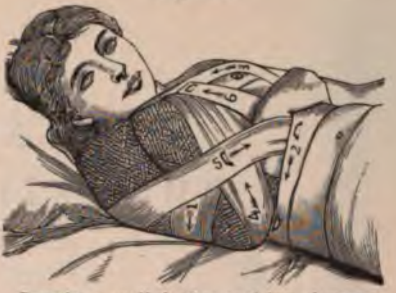
Back dressing lying ready for application; showing also the deep dressing and padding in the axilla and behind the arm.

---

[1] W. W. Cheyne.

1); the second also passes round the body, but below the elbow (2), thus catching the portion of the dressing overhanging the elbow and also the lower edge of the front dressing; the next passes round the body and over the top of the shoulder on the side operated on, thus catching the portion of the dressing projecting above the shoulder (3); the bandage then passes down behind but parallel to the arm, turns round below the elbow, runs obliquely upwards in front to the top of the opposite shoulder (4), then obliquely back again behind the body (thus fixing the upper angles of the dressing in front and behind) to the middle of the arm, over which it passes obliquely downwards (5), to go under the wrist and end at the top of the shoulder (6)—in this way completing the fixing of the dressing to the arm, and at the same time acting as a sling for the hand. A bandage six yards long generally does this exactly.

Fig. 833.

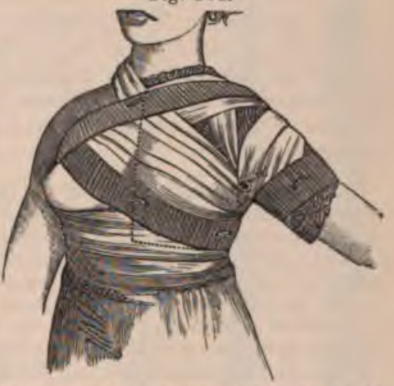


Dressings applied after excision of mamma and axillary glands to show the arrangement of the dressings and bandages.

The dressing is completed by applying a binder which covers the entire chest, and incloses the dressing and the limb of that side.

The axillary glands occasionally require excision as secondary growths from cancerous infection subsequent to the removal of the breast. The operation should be thorough, and the large cavity should be thoroughly drained. The dressing should be antiseptic (Fig. 834), and not unlike that for the breast, but should be applied to the chest, shoulder, and upper arm.

Fig. 834.



Dressing in cases of operation on the axilla alone.[1]

Caustics should always be preferred to the knife when ulceration has taken place, and the adhesions are deep or widespread. The most manageable and useful application is the anhydrous sulphate of zinc mixed with the strong sulphuric acid until it forms a thick paste.[2] This paste should be freely applied repeatedly to the open surface, and followed by poultices and carbolic washes until the entire mass is removed; cicatrization frequently follows the use of this caustic. Or, caustic arrows may be prepared by mixing a concentrated solution of chloride of zinc with flour until a firm plaster is formed; this mass should then be cut into arrow-shaped points; they are inserted by first thrusting the point of a sharp knife under the tumor and then pushing the sharp point of the arrow into the wound until the whole mass is lodged under the skin; repeat the insertion at intervals of an inch until the tumor is surrounded; apply poultices to hasten the sloughing and separation of the growth.

---

[1] W. W. Cheyne.

[2] Sir J. Y. Simpson.

XI.

THE EXTREMITIES.

CHAPTER LXIII.

AMPUTATION.

An amputation is required to preserve life from the consequences of disease or injury, and is justifiable only when the question of recovery by other means is placed beyond all reasonable doubt, or the presence of an incurable disease is a source of such evil or discomfort as to render the loss of the limb desirable or beneficial to the patient.[1]

No operation is undertaken by the conscientious surgeon with so much reluctance and real pain, and with such a profound sense of personal responsibility.[2] And to the more indifferent operator an amputation frequently assumes an extreme importance by having all the circumstances attending the loss of a limb critically, and often savagely, reviewed in the courts.[3] These responsibilities can be properly met only by the most deliberate care in the management of every detail in each case, aided by the best available counsel. The final judgment as to the necessity of an amputation in any given case must be sustained by the latest surgical experience, for an amputation that would formerly have been justified would now be repudiated by the best authority, and the operator justly charged with ignorance and unskilfulness.[3]

The instruments which are specially required to form a complete amputating case, are a long and short knife and catling (Fig. 835), metacarpal saw, scalpel, tenaculum, saw, bone forceps, artery forceps, needles, tourniquet, and elastic bandage.[4]

The knife selected for each special operation should be of about twice the length of the diameter of the limb. The catling is a double-edged knife, the two edges being parallel until they converge to form the point; the scalpel is large and strong, having a firm handle. The saw (Fig. 836) should have a strong back and be well set. The bone forceps should be cutting (Fig. 168). The tourniquet should be strong (Fig. 8), and applied as in Fig. 9. The elastic bandage is seen in Fig. 5, and its application in Fig. 6. The artery forceps may be dog-toothed (Fig. 11), or with a slide (Fig. 12). There should be six or more catch forceps (Fig. 14).

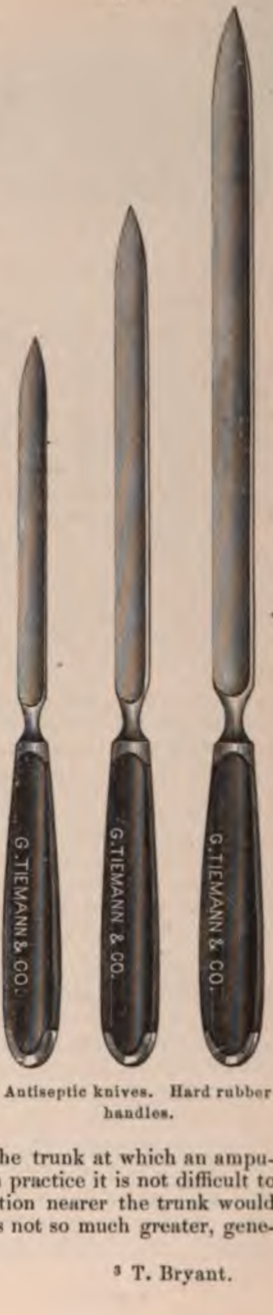
The time of the operation must be fixed with due regard to the cause which necessitates the amputation, and the condition of the patient. There is a time when interference must be avoided, not less than courted, but the limits of the two periods are not always well defined, and must be left to the judgment of the surgeon in each individual case. In general, it may be advised (1) when injuries necessitate immediate amputations, but the operation should be performed during the period of reaction from shock, or between the sixth and twenty-fourth hour after the accident; (2) If the disease is acute, avoid the period of active inflammation, rapidly-spreading gangrene, and acute pyæmia; (3) In chronic affections the surgeon should regulate the time of operation according to the principles detailed.

---

[1] F. C. Skey. [2] S. D. Gross. [3] Elwell. [4] F. Esmarch.

The place of amputation must be determined with regard (1) to the safety of the patient, and (2) to the serviceableness of the resulting limb; the former must be settled in accordance with the teachings of operative, the latter of mechanical surgery. Fortunately, experience of both branches of surgical art is now in harmony in the selection of the place in most instances. Two principal divisions of amputations have been recognized, based on the place of operation, namely: (1) in the continuity of shaft; (2) in the contiguity or articulation of bones.

Fig. 835.


G. TIEMANN & CO.
G. TIEMANN & CO.
G. TIEMANN & CO.

Antiseptic knives. Hard rubber handles.

These divisions are now comparatively unimportant, as experience proves that, both for safety to the patient[1] and serviceableness of stump, no distinction should be made between amputation in the continuity and contiguity, with the exception of the ankle.[2] In the upper extremity, all the conditions unite in favor of the least possible sacrifice of parts,[3] for the safety of the patient is in proportion to the distance of the wound from the body; and the value of the stump, in prehension, depends upon the number of articulations preserved. In the lower extremity the same rule applies to the wound, but as the stump is to be used in locomotion, it requires breadth and firmness to sustain contact with the artificial appliances used in progression, and hence a place of amputation must be selected which will secure these conditions. This place is not always the farthest point from the trunk at which an amputation could be performed in a given case. But in practice it is not difficult to harmonize the two indications; when the amputation nearer the trunk would give the better stump, the danger of the wound is not so much greater, gene-

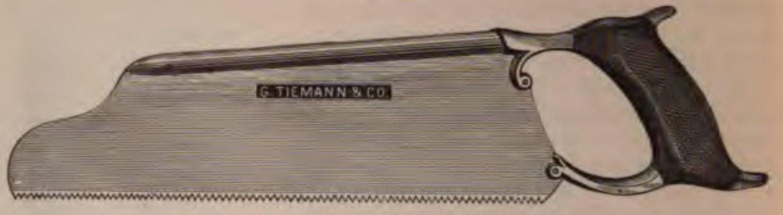
---

[1] Legouest.

[2] E. D. Hudson.

[3] T. Bryant.

Fig. 836.



Amputating saw.

rally, as to forbid accepting the slightly increased risk for the life-long advantage gained.

The immediate preparation for an amputation should include all of the appliances necessary to render the wound entirely aseptic, as fully stated in the section giving the details of an antiseptic operation. The limb to be amputated should be scrupulously cleaned, disinfected, and shaved as directed. The operator and his assistants should clean and disinfect their hands; care should be taken that during the operation irrigation with warm or hot bichloride solution is sufficiently constant.

The method of operation should aim to secure a well-nourished covering of the stump, neither scanty nor redundant, and freely movable cicatricial tissue. To obtain such results: (1) the soft parts must be very nicely adapted to the surface to be covered and well supplied with bloodvessels: (2) the cut surface of bone must be immediately covered by the periosteum,[1] or the deep fascia of the part, in order to prevent the superficial fascia and integument from becoming too firmly attached to the cicatricial tissue of the end of the bone. These results are secured by raising the periosteum with the soft tissues and applying it to the cut end of the bone.

The objection to the peritoneal covering of the bone that osteophytes are liable to form on the extremity,[2] and render the stump tender, are trivial when compared with the advantages which follow the protection which it affords from necrosis and osteo-myelitis, and the basis which it forms for a movable covering. If osteophytes become troublesome, they may readily be removed by a slight operation.

No one method can be adapted to every part and all the conditions under which amputations are performed, and hence great discretion is always required in selecting that method in any given case which will fully meet all indications. It also frequently happens that the mutilation of parts is so great that the surgeon can form the coverings of the stump by no fixed rules, but must exercise his ingenuity in patchwork. But if the conditions essential to a sound and useful stump are constantly kept in view, any of the stereotyped or extemporized methods may be made, with patience and dexterity, to yield the most gratifying results. The recognized methods of amputation are: (1) the circular; (2) the single flap; (3) the double flap; (4) the rectangular; (5) the bilateral flap; (6) the periosteal flap.

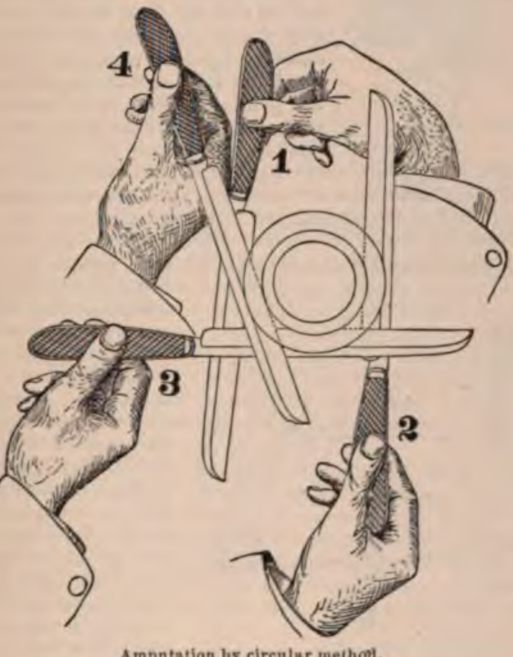
---

[1] McGill.

[2] L. Ollier.

The circular operation can be executed more quickly by the following than by the ordinary method (Fig. 837): Stand upon the right side of the limb, the left foot thrown forward and placed firmly upon the floor, the right knee bending sufficiently to give freedom of motion to the body; grasp the limb above the point of operation with the left hand, and take the handle of the knife between the thumb and fore and second fingers of the right hand, lightly supported by the other fingers; stooping sufficiently to allow the right arm to encircle the limb readily, carry the knife around until the blade is nearly perpendicular to the long axis of the limb on the side next to you with the point downwards, and the hand above the limb, 1 (Fig. 837).[1] Commence the cut with the heel of the knife, giving slightly sawing motions, and bring the hand under the limb, 2, and then directly upwards upon the side next to you, 3, until the heel touches the point of commencement, 4; the handle of the knife held thus delicately will change its relative positions as it passes around the limb without the slightest embarrassment to the operator; if the handle is firmly grasped (Fig. 842) in the hand, the incision cannot be completed without the aid of the other hand, or an awkward movement of the hand holding the knife; the ease with which the incision is completed will depend much upon whether it commences well down upon the side of the limb next to the operator; raise the skin from the first layer of muscles by dissection, and turn it upwards, two or three inches, according to the diameter of the limb, like the cuff of a coat. Divide the first layer of muscles at the margin of the retracted integument by the circular incision (Fig. 837), as of the skin; raise this layer

Fig. 837.



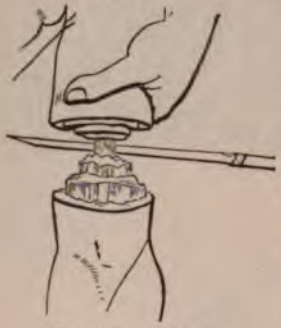
Amputation by circular method.

---

[1] McGill.

with the knife, and draw it still further upwards; divide the last layer of muscles down to the bone (Fig. 838) by the same sweep of the knife as before given. Saw the bone at the apex of the cone.

Fig. 838.

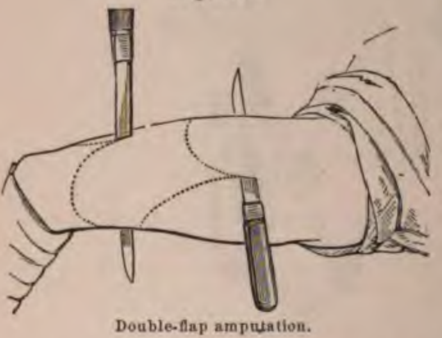


Circular amputation.

The single flap, or a short anterior and long posterior flap, is performed as follows: The patient being placed in the proper position, the operator, standing upon the right side of the limb, grasps the thigh with the left hand, placing the fingers and thumb upon opposite points; he then applies the heel of a long amputating knife on the further side of the limb at the ends of fingers, and drawing it in a semicircular direction over the limb to the end of the thumb, with this single sweep divides all the soft parts down to the bone; without entirely removing the knife it is withdrawn sufficiently to enter the point at the angle of the wound, and is made to transfix the limb, passing under the bone, and emerging at the angle of the wound on the opposite side; a flap is then cut of the requisite length from the posterior part of the thigh; the flaps are retracted, the knife carried around the bone, and the saw applied at the highest part of the wound.

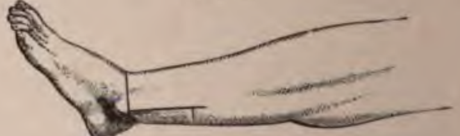
Double flaps are formed as follows: The patient being properly arranged, the operator, standing upon the side of the limb, grasps the soft parts and brings them forward; he then transfixes the limb, the knife grazing the upper surface of the bone, and makes a short anterior flap; the knife is reintroduced, and passing under the bone a posterior flap is made longer than the anterior (Fig. 839), to compensate for the greater retraction; the operation is completed as in the former method.[1] Flaps may also be made from the sides of the limb; the knife is introduced in the centre of the limb, directly down to the bone, on one side of which it is passed to the opposite side of the limb and a flap is then formed (Fig. 839); the knife is then introduced and a flap [illegible] made from the opposite side; the flaps are strongly retracted, and the bone [illegible] sawed.

Fig. 839.



Double-flap amputation.

Fig. 840.



Lines of incision in Teale's amputation.

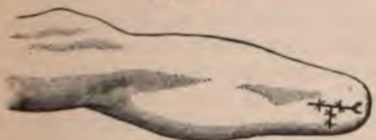
The rectangular flaps[2] are made as follows: The operator makes a longitudinal incision on either side of the limb (Fig. 840), in length equal to two-thirds of the circumference of the limb at this part; a second incision, extending to the bone, unites the lower extremities of these two incisions; this quadrilateral flap is raised from the bone; a third incision made transversely down to the bone, forms the posterior flap; both flaps are raised and firmly retracted, the bone sawn at its point in the flaps, and the flaps united (Fig. 841).

---

[1] Sir W. Fergusson.

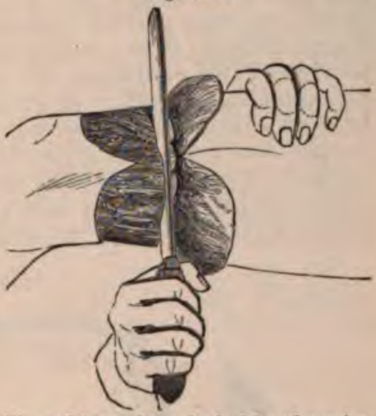
[2] Teale.

Fig. 841.



Teale's amputation; stump.

Fig. 842.

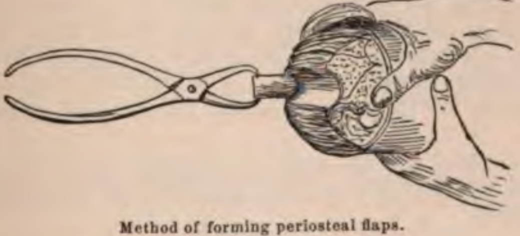


Flaps of skin and circular incision of muscles.

The modified flaps include only the skin, or may involve all of the soft parts down to the bone. The former consists of double flaps of the integuments and circular incision of the muscles (Fig. 842);[1] the flaps should be sufficient to meet without effort, should correspond in size, and not be made too arched; in dividing the muscles, the knife, unless the limb be of unusual dimensions, should be carried down to the bone at once, and this can only be done by the application of considerable force, great care being taken that the muscular mass behind the bone be not pushed before the knife, but divided without displacement from its natural relations to the parts around. When the limb is very large, it would be well to divide the superficial muscles first and allow them to retract, before the division of the remainder.

The periosteal flap is most perfect when it is raised with the other flap; to effect this readily the incision in any form of operation may be directly down to the bone; if the bone is then divided, an assistant may grasp the extremity with stout forceps while the operator raises the periosteum, beginning at the extremity of the cut bone; the periosteotome may be used, but in general the thumb-nails will be found most efficient. The periosteum, thus raised, covers the central part of the flap (Fig. 843), and when the flap is brought over the extremity, the periosteum makes a perfect covering, while the tissues between the skin and periosteum, being uninjured, rapidly unite.

Fig. 843.



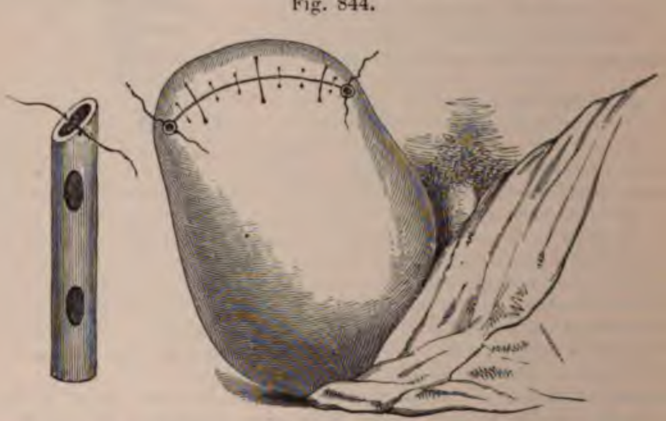
Method of forming periosteal flaps.

---

[1] F. C. Skey.

The bone must be carefully divided as follows: The periosteum having been cut completely around the bone, as high up in the flap as possible, employ the saw as does the cabinet-maker; first apply the heel, and draw the saw slowly but firmly across the bone to make a groove, and then move it with as much rapidity as the operator may choose, until the bone is nearly divided, when it is to be moved more slowly to avoid splintering the last connections; with the bone forceps clip off any sharp or projecting edges, and bevel the end of the bone smoothly. Where there is a single bone it will be found easier to apply the saw nearly perpendicularly on the side opposite to the operator; where there are two bones the saw should be first and last applied to the larger and firmer bone, the smaller bone being completely divided while the saw is engaged in the larger bone.

Fig. 844.



A stump showing mode of applying suture and drainage-tube. A drainage-tube is shown at the left.

The wound must be closed and dressed, according to the principles already given, viz., the vessels having been secured, (1) insert two or three deep and several superficial interrupted sutures (Fig. 844); (2) place in the angles of the wound proper drainage-tubes so as to relieve it of all accumulating fluids; (3) support the parts in such manner by splints, or slings, or pads, that it need not be moved in dressing; (4) apply such dressings as will support and protect the wound, but admit of easy change. The external dressings should be iodoform gauze, covered by absorbent cotton, held in place by the bandage.

The application of very hot water to amputation wounds has been highly recommended[1] as a method of arresting hemorrhage and preparing the surfaces for prompt union.

I. AMPUTATIONS OF THE HAND.

Operative and mechanical surgery unite in enforcing the rule that in the hand no part should be removed that can be saved;[2] no instrument-maker can contrive anything half so good even as one finger.[1] A great variety of methods of operation have been devised to meet the emergencies which arise from injuries of the hand requiring amputation (Fig. 845).

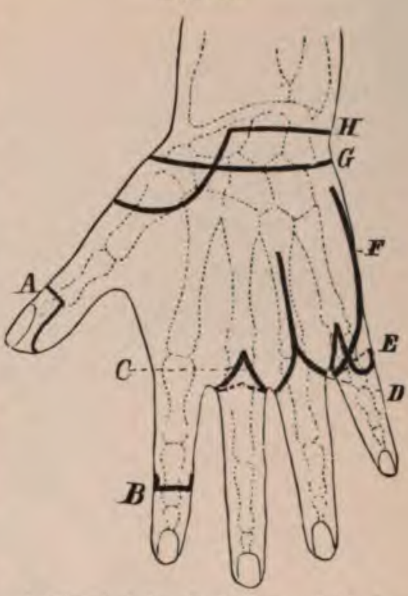
---

[1] T. R. Varick.

[2] C. J. Guthrie.

The phalanges are often injured in such a manner as to compel the surgeon to perform a circular, flap, or some modified operation to secure the requisite covering. But when the parts will admit, the single palmar flap is preferable in all amputations of the fingers, as the cicatrix is by this method removed to the dorsal surface, the stump is firm and well adapted for use, and the tactile sensation is less impaired.

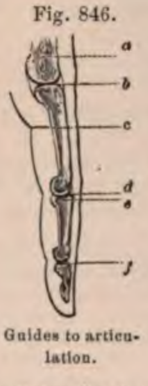
Fig. 845.



A. Disarticulation of phalanx, anterior flap. *B.* Amputation in continuity, circular. *C.* Metacarpo-phalangeal disarticulation. *D.* Amputation of a metacarpal bone in continuity. *E.* Disarticulation of little finger. *F.* Dislocation of fifth metacarpal. *G.* Amputation of wrist, circular. *H.* Amputation of wrist.

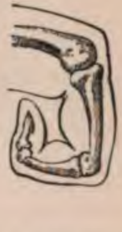
The anatomical guides to the articulations are the transverse depressions (Fig. 846) in the skin on the palmar surface. Between the bony projections at the side of the finger, at the articulation of the second and third phalanges, a depression marks the position of the articulation; a prominence is readily detected on the dorsum of the second phalanx just in front of its articulation with the distal extremity of the first phalanx; the articulation of the first phalanx with the metacarpal bone is immediately behind the bony prominences of the proximal extremity of the first phalanx. The transverse depressions in the skin, on the palmar surface of each finger, are three in number, and have the following relation to the corresponding articulations, commencing with the extremities of the fingers, held in an extended position: The first depression is situated about a line and a half above the articulation, *f* (Fig. 846), between the third and second phalanges; the second depression is situated exactly over the articulation, *d* (Fig. 846), between the second and first phalanges; the third depression, *c* (Fig. 846), situated at the commissure of the fingers, is about an inch below the articulation, *b* (Fig. 846), of the first phalanx with the metacarpal bone. When the finger is placed in a state of extreme flexion, it will be seen (Fig. 847) that the relations of the articulation change, and hence the

Fig. 846.



Guides to articulation.

Fig. 847.



Phalanx flexed.

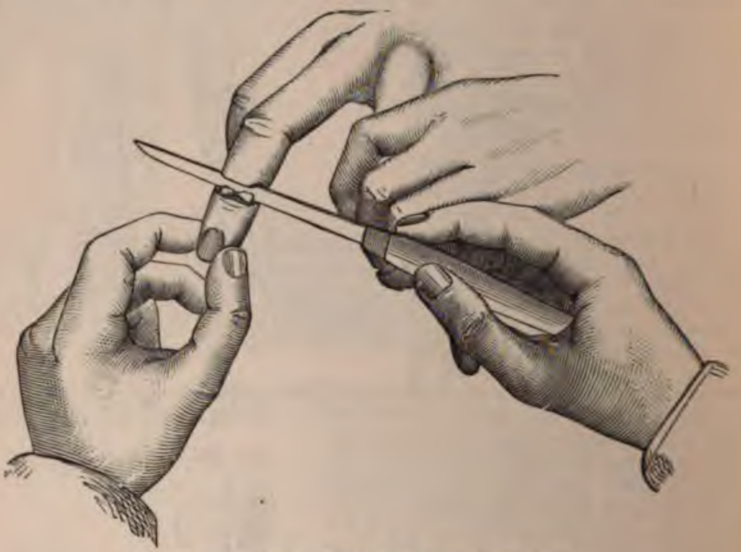
---

[1] R. Liston.

point at which the articulation is to be sought will depend on the position of the finger.

In disarticulation of the last phalanx, pronate the hand, and require an assistant to hold apart the sound fingers; seize the phalanx with the thumb and index finger, and bend it to an angle of forty-five degrees; recognize the line of the joint as follows: On the dorsal surface there is a well-marked fold in the skin, and the joint is half a line below it; or, if this is not found, recognize the dorsal projection formed by flexion, and cut half a line beyond it; or, seek the termination of the palmar fold, and find the joint half a line below it, take a straight bistoury, and applying its heel perpendicularly on the recognized extremity of the interarticular line, cut from left to right a very small semicircular dorsal flap, and terminate it at its other extremity, dividing the capsular ligament (Fig. 848); enter the joint, cut the lateral ligaments; pass the knife through the joint, and make a palmar flap. In amputations through the shaft of a phalanx the palmar flap may be made by transfixion (Fig. 849).

Fig. 848.



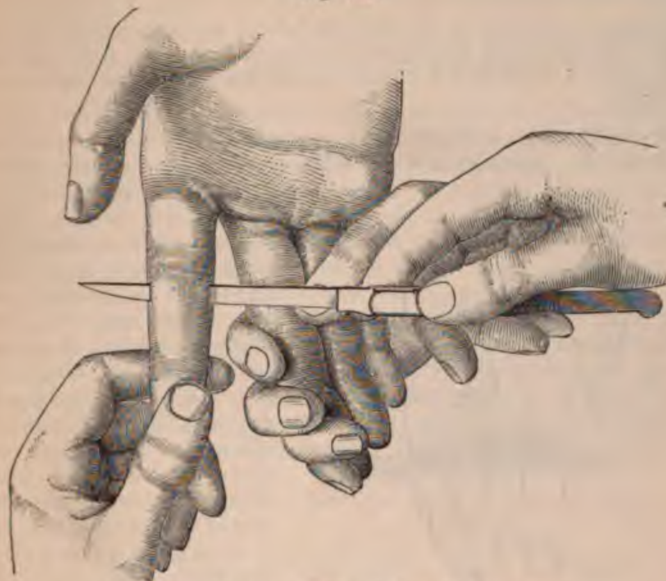
Amputation of part of a finger by cutting from above.[1]

When the distal phalanx alone is involved, as in caries or necrosis, the nail and soft parts should, if possible, be preserved; it is nearly always feasible, and, if the periosteum has not been destroyed, it is not unfrequently followed by reproduction of the phalanx, though rarely in a perfect manner.[2] Bring the palmar flap into position, secure it by a narrow bandage laid over the stump in the direction of the long axis of the finger, then make fast by a few turns of the roller.[3] To disarticulate the second phalanx the proceeding is the same, only the dorsal incision should start on each side on a level with the palmar fold in the skin.[4]

---

[1] J. E. Erichsen. [2] S. D. Gross. [3] F. H. Hamilton. [4] Lisfranc.

Fig. 849.

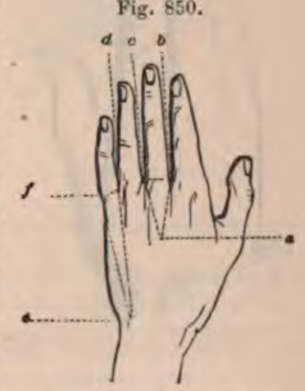


Amputation of a finger. Cutting the flaps by transfixion.[1]

The entire finger may be removed at the metacarpo-phalangeal articulation.

The joint is located an inch above the commissure, or it may be recognized by making strong traction on the finger and thus separating the joint.

Fig. 850.



Amputation of entire finger.

Grasp the finger in a prone position on its palmar and dorsal surfaces by the fingers and thumb of the left hand, and flex to an angle of forty-five degrees; commence an incision on the dorsal aspect of the joint a quarter of an inch above at *a* (Fig. 850), and carry it down to the commissure, *c*, then across the palmar surface to the opposite side, *b*, in the fold of the skin, the finger being forcibly extended; thence, the finger being again flexed, the incision is continued upwards to *a*; dissect the borders of the wound from the head of the phalanx, enter the joint on its dorsal aspect, divide the extensor tendons and lateral ligaments, increase the flexion with an effort to luxate the joint which renders the flexor tendons easy of division. To give greater symmetry to the hand the head of the metacarpal bone may also be removed. Or, double flaps may be made, *a*, *b*, *c* (Fig. 850).

---

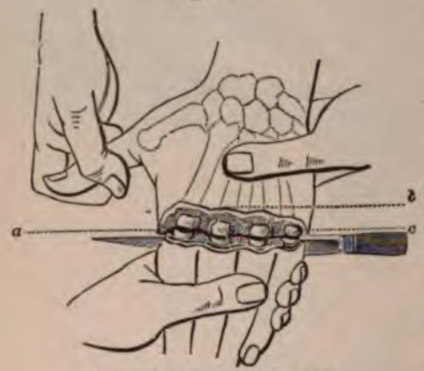
[1] J. E. Erichsen.

The four fingers may be removed at a single operation.

The distal extremities of the metacarpal bones are not all on the same line; those of the index and ring fingers are nearly on a level, while that of the middle finger is about half a line lower, and that of the little finger is half a line higher.

The hand being well pronated, grasp the four fingers with the left hand and flex them moderately while an assistant supports the hand and retracts the skin as much as possible; with a straight, narrow knife, make a curved dorsal incision, *a*, *b*, *c* (Fig. 851) with its convexity looking downwards, from six to eight lines below the heads of the metacarpal bones, from the index towards the little finger if the left hand, and in the opposite direction if the right; the extensor tendons being exposed by the retraction of the integuments, which is assisted by a few strokes of the knife, open each of the metacarpo-phalangeal articulations; divide the extensor tendon first, then the lateral, and finally the palmar ligamentous attachments; carry the knife through the articulations to the palmar aspect of the phalanges, and cut out a flap, which is limited anteriorly by the folds in the skin at the base of the fingers on their palmar surfaces.

Fig. 851.



Amputation of all the fingers.

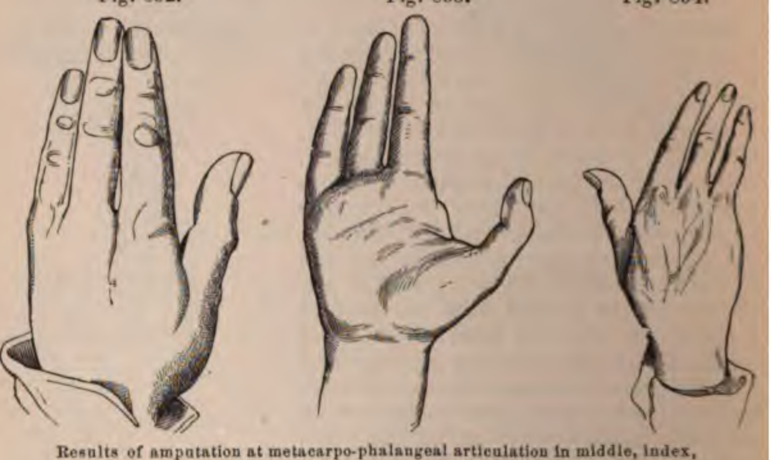


Fig. 852. Fig. 853. Fig. 854.

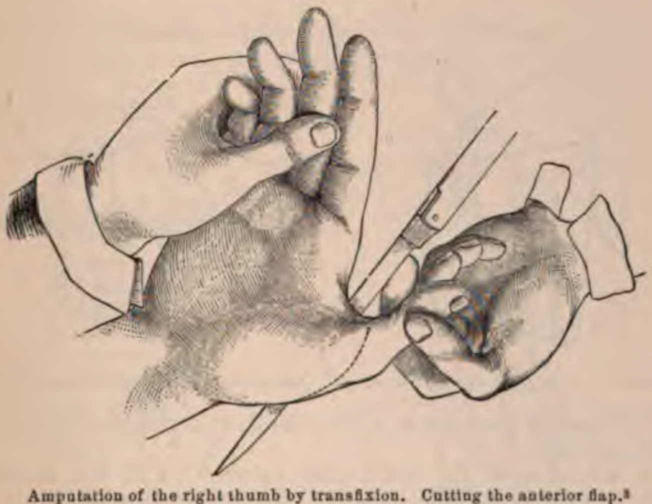
Results of amputation at metacarpo-phalangeal articulation in middle, index, and ring fingers.

By the same method, two or three fingers may be amputated, the sound fingers being held aside; the dorsal flap is then formed by the point of the knife; or the hand may be held in the supine position and the flap made first from the palmar surface.[1] The appearance of the stump is improved by sloping the projecting portion of each knuckle with cutting pliers.[2]

The results of these amputations are excellent both as regards the usefulness of the hand and its appearance (Figs. 852, 853, 854).

The thumb may be amputated at its phalangeal or metacarpal articulation. The first is performed in the same manner as that of the fingers, but the removal at the metacarpo-phalangeal articulation requires large flaps, owing to the great size of the head of the metacarpal bone. Make an incision on the dorsal aspect, convex upwards, the centre being a little above the joint, and the extremities terminating on each side at the end of the palmar transverse fold, extend the thumb and make a palmar convex incision, uniting the extremities of the first, the centre extending midway between the transverse cutaneous fold alluded to and that marking the articulation of the first and second phalanges; open the joint and complete the disarticulation, removing the sesamoid bones. The palmar flap, applied to the end of the bone, should accurately fit the curved incision above. Or, the flap may be made by transfixion (Fig. 855).

Fig. 855.



Amputation of the right thumb by transfixion. Cutting the anterior flap.[3]

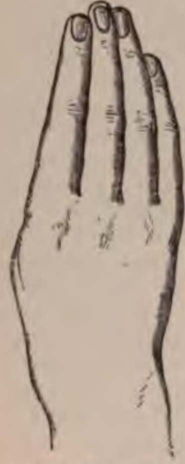
The appearance of the hand after amputation of the thumb is good (Fig. 856); the power of grasping is lost, but prehension remains.

A single metacarpal bone is removed by an incision on the dorsal aspect, corresponding in length with the portion of the bone to be removed. Separate the soft parts cautiously from the bone,

---

[1] Lisfranc. [2] S. D. Gross. [3] J. E. Erichsen.

Fig. 856.

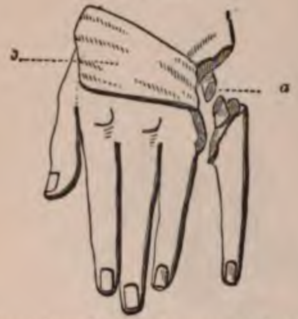


Result of amputation of thumb.

the knife being carried parallel with its long axis to avoid wounding the palmar arch; having made the incisions on both sides, pass the point of the knife under the bone, so as to appear at the opposite side, and then, by carrying it forwards in contact with the under surface of the bone, divide the soft parts at one section; if the operation is of either the third or fourth metacarpal bone, the section should be made with the bone forceps; if of the metacarpal bone of the thumb, saw it perpendicularly to its axis; if of the index-finger, make a section obliquely from without inwards, the hand being supine; if of the little finger, from within outwards (Fig. 857), *a*, the soft parts being withdrawn by the retractor, *b*.

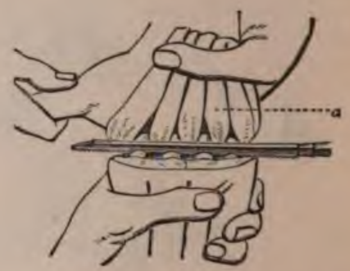
Amputation of the four metacarpal bones (Fig. 858) is made as follows: Make a palmar flap as in disarticulation of all the fingers and a similar incision on the dorsum; pass the knife into the interosseous spaces, separate the muscular attachments and divide the periosteum, apply a five-tailed retractor, *a* (Fig. 858), and saw the bones with a metacarpal saw.

Fig. 857.



Amputation of a single metacarpal bone.

Fig. 858.



Amputation of all of the metacarpal bones.

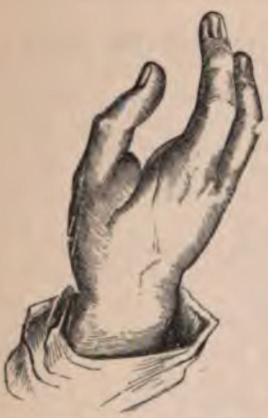
The condition of the hand after amputation of the metacarpal bones is favorable to many kinds of work (Figs. 859, 860).

Disarticulation of the first metacarpal bone is performed as follows:—

The joint is of a mixed character, between arthrodial and ginglymoid; on its dorsal surface it is almost subcutaneous, but covered with thick muscle on its palmar aspect; the radial artery passes around its ulnar side; it has a loose capsule; the joint runs in an oblique direction, in a line drawn from its external side to the root of the little finger; it is easily determined by the projection of the enlargement of the head of the bone, on pressing the thumb into the palm; or, it lies an inch and a quarter below the styloid process of the radius.

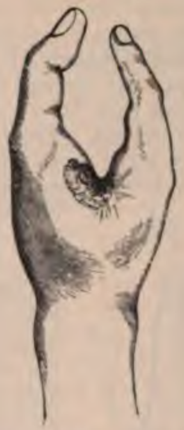
Hold the hand in a position between supination and pronation; make an incision along the dorsal surface of the metacarpal bone of

Fig. 859.



Hand after amputation of metacarpal bones and first two fingers.[1]

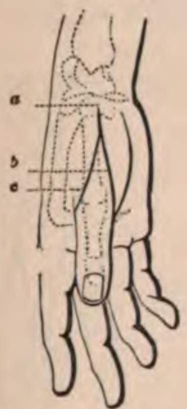
Fig. 860.



Hand after removal of metacarpal bones and three fingers, leaving thumb and little finger.[1]

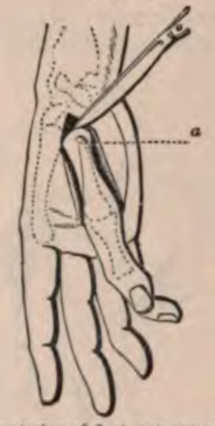
the thumb, commencing six lines above its articulation, *a* (Fig. 861), with the trapezium, and extending through all the tissues down to

Fig. 861.



Incision in removal of first metacarpal bone.

Fig. 862.



Amputation of first metacarpal bone.

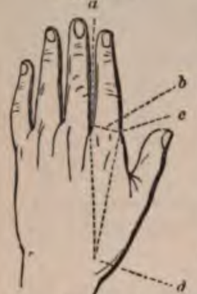
the bone, to the inner side of the head of the first phalanx of the thumb, on a level with the commissure, *b*, between the thumb and index-finger; carrying the hand to pronation, continue the incision around the palmar surface of the phalanx to its outside, *c*, and thence to the dorsum of the metacarpal bone to join the first incision about its middle; detach the muscles and integuments from either side of

[1] J. E. Erichsen.

the bone, and open the articulation from its dorsal aspect, *a* (Fig. 862); then endeavoring to dislocate the bone outwards, complete the division of its remaining attachments.

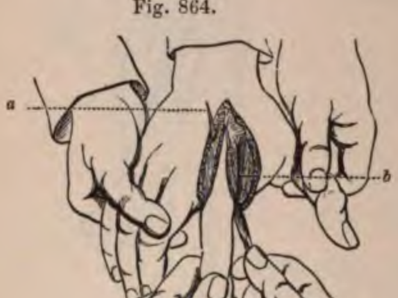
Disarticulation of the second metacarpal bone is rendered especially difficult on account of the prolongation of that part of its head that is in relation with the trapezoid, os magnum, and third metacarpal. The hand held in pronation, the thumb and fingers separated, make an incision, commencing about half an inch in front of the styloid process of the radius, but on a line with the second metacarpal bone, *d* (Fig. 863), and continue to the internal side of the base of the first phalanx, *a*; now carry it around the palmar surface in the cutaneous fold—represented on the dorsum by the line *b*, *c*—to the point *c*, and thence to point of commencement, *d*; dissect the soft parts by keeping the knife close to the bone, the wound being held apart; carry the knife up along the internal side of the bone to the union of the two metacarpal bones, and, turning its edge inwards, divide the interosseous ligament, and, in the same manner, enter the knife into the articulation of the metacarpal bone with the trapezius; the anterior and posterior ligaments are next divided, the bone dislocated, and the knife entered flatwise and horizontally under the upper part of the bone *a* and *b* (Fig. 864), is carried downwards, completing the operation; care should be taken in dividing the ligaments not to penetrate any adjoining articular cavity.

Fig. 863.



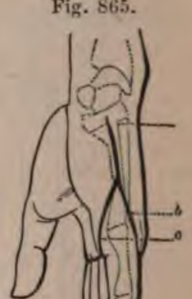
Line of incision for removal of second metacarpal bone.

Fig. 864.



Amputation of first metacarpal bone.

Fig. 865.



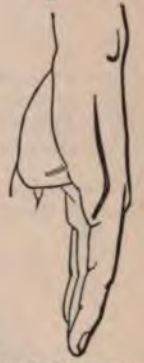
Incision for removal of fifth metacarpal bone.

Disarticulation of the fifth metacarpal bone may be performed by two methods:—

The unciform receives the fifth metacarpal bone, upon a surface concave from behind forwards; the line of articulation, if prolonged, would fall upon the middle of the second metacarpal bone.

(1) Pronate the hand and commence an incision one line above the articulation *a* (Fig. 865), and carry it along the dorsum to the commissure, *b*, then under the finger, along the fold of the integument to the opposite side, and from thence back to the point of departure, *a*; dissect the soft parts from the bone and disarticulate. (2) The hand being held in a state of forced pronation (Fig. 865), commence an incision six lines above the carpo-metacarpal joint, *a*, and carry it down in a straight line to the inner border of the first phalanx of the little finger, until it meets the depression at the base of the little finger, on its palmar surface, *b*; then continue it around the base of the finger following this depression exactly; and, lifting the little finger, continue the incision around to its inside, *c* (Fig. 865), and upwards to join the first portion about opposite to the centre of the metacarpal bone; detach the integuments and muscles from the bone, and divide its articular connection with the point of the bistoury in the manner already described. The wound after the operation is seen in Fig. 866.

Fig. 866.



Hand after amputation of fifth metacarpal bone.

Disarticulation of fourth and fifth metacarpal bones is as follows: Make a transverse incision a little in front of the articulations, another parallel to the axis of the metacarpal bones, upon the dorsum of the fifth, in order to cut upon that part a dorsal flap which is to cover the whole ulnar side of the wound after the operation; the disarticulation is thus effected, and a small flap formed, which must be separated down to its base in the palm of the hand, in order to be able to raise it upon the transverse branch of the wound.[1] The same process is adapted to any other two metacarpal bones.

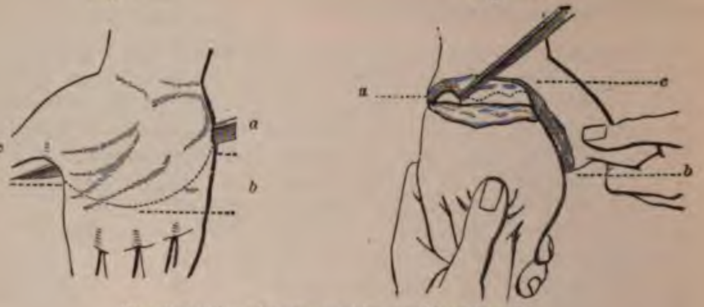
Disarticulation of the metacarpal bones of the four fingers is performed thus: Hold the hand in the position of forced supination and introduce, opposite the articulation of the fifth metacarpal with the unciform bone, a small, straight knife between the bones and the soft parts, carrying it a little below the projections formed by the unciform and the trapezium, so as to bring out its point below the thumb; carry the blade of the knife along the palmar surfaces of the metacarpal bones, and cut out a large flap of an elliptical outline, *a*, *b*, *c* (Fig. 867), turn the hand in a prone position, and make a semicircular incision across its back, two-thirds of an inch below the line of the articulations, and carrying the knife through the tissues connecting the thumb with the index-finger, *a*, *b*, *c* (Fig. 868), join the first incision; while an assistant is drawing the integuments upwards, hold the metacarpus in the left hand, disarticulate from the front, commencing with the metacarpal bone of the index or little finger, according as the operation is upon the right or left hand.[2]

---

[1] Velpeau.

[2] Maingault.

Fig. 867. Fig. 868.

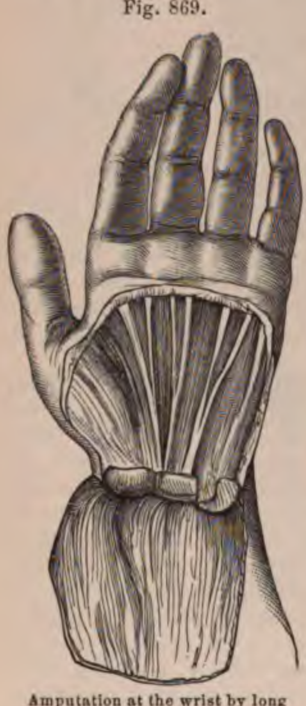


Disarticulation of metacarpal bones of four fingers.

Disarticulation of hand at the wrist-joint gives the best results when a flap is taken from the palmar surface of the hand.

To determine the articulation: (1) Strongly bend the hand backward; the summit of the angle formed by it with the forearm indicates the radio-carpal articulation. (2) Feel in front the transverse process of the radius; the joint is one line below it, and about half an inch above the crease in the skin that separates the palm of the hand from the forearm. (3) Determine the summit of the styloid processes, and draw a transverse line between them; this line will be two lines and a half below the joint.[1]

Fig. 869.



Amputation at the wrist by long palmar flap.[2]

A single palmar flap is made as follows: An assistant holds the hand in a supine position; grasp the extremity in the palm of the left hand, placing the thumb and forefinger on the extremities of the styloid processes; make a semicircular incision on the palm (Fig. 869) from just below the processes; dissect the flap and turn it back, make a small flap at the dorsum, and divide the tendons, the radio-carpal and lateral ligaments.

II. AMPUTATION OF THE FOREARM.

It is important to preserve as long a stump as possible of the forearm for various occupations, and for the application of apparatus. Its arteries are the radial, ulnar, and anterior and posterior interosseous; two bones are to be divided, of different diameters, at different parts of the limb.

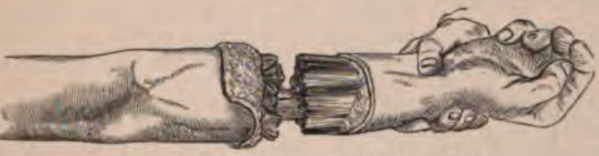
---

[1] Malgaigne.

[2] J. E. Erichsen.

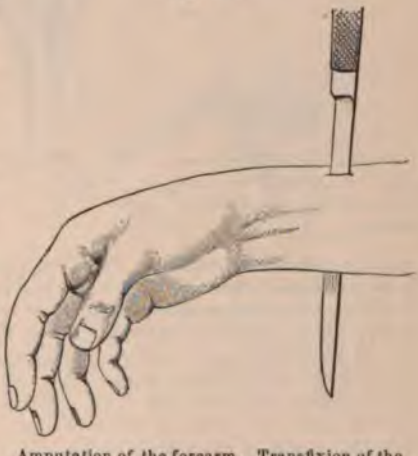
Semicircular skin flaps and circular of the muscles is the best method of amputation in any part of the forearm. The skin is usually too thin for one long skin flap, and there are too many tendons for the rectangular flap. Operate thus: The arm being held with the hand supine, so as to render the bones parallel, cut from the anterior and posterior surfaces semicircular flaps of suitable length, including the tissues above the muscles; turn these flaps backwards, and with long knife divide the tissues to the bone (Fig. 870); saw the two bones at the same time.

Fig. 870.



Amputation of the forearm by mixed method.[1]

Fig. 871.



Amputation of the forearm. Transfixion of the anterior flap.[2]

The flap may be single or double. The arm being held in the position between pronation and supination, with the thumb uppermost, so that the radius and ulna are in one line, enter a sharp-pointed knife close to the inner edge of the radius and bring it out opposite at the edge of the ulna (Fig. 871); if a single flap is to be made, it must be taken from the anterior face, and be long enough to completely cover the stump; if a double flap is preferred, make an anterior flap the length of half the diameter of the arm, and a posterior flap of equal length; turn back the flaps, divide the tendinous muscular or interosseous fibres not cut through, and divide the bones as in the circular operation.

III. AMPUTATION AT THE ELBOW-JOINT.

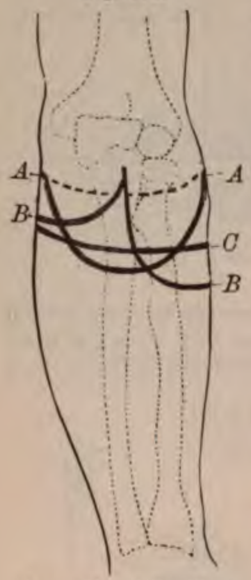
Amputation of the elbow-joint is to be preferred to amputation through the arm, if no artificial arm is to be applied, as the stump is broad and firm, and can be made more useful. Several methods are adapted for this articulation (Fig. 872). The circular and single anterior flap methods are generally to be preferred.

---

[1] T. Bryant.

[2] J. E. Erichsen.

Fig. 872.



Amputation at the elbow-joint. *A*. Anterior flap. *B*. External flap. *C*. Circular method.

Fig. 873.

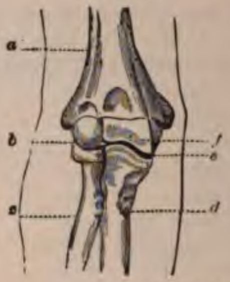
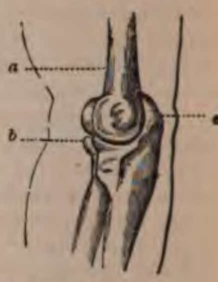


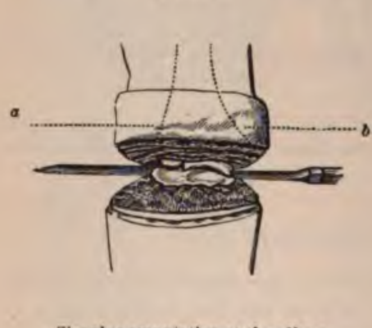
Fig. 874.



Anatomical points about the elbow-joint.

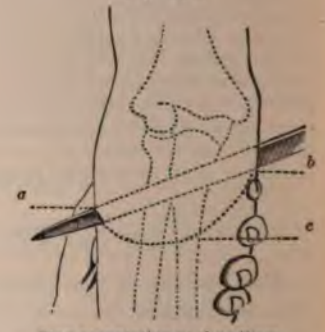
The exact position of the joint is determined by careful attention to the anatomical relations of the following osseous prominences about the joint: the epicondyles, or the most prominent points on the condyles of the os brachii, *b*, *c* (Fig. 874), are recognized, the internal more readily than the external; also the olecranon, *c* (Fig. 874), a line drawn through the lower points is, on the outside, a quarter of an inch above the interarticular line, *b* (Fig. 873), and on the inside three-quarters of an inch; the articulation of the radius and humerus is transverse, that of the ulna irregular, and owing to its projections must be entered externally. Two facts result: first, that the articular interline is very oblique from without inwards and from above downwards; second, that it is very much below the tuberosities of the humerus. If, then, in cutting the anterior flap, its base is extended up to the level of these tuberosities, it will almost always be too short to cover the bone, which will project, especially on the inside and downwards; therefore, enter the knife one inch below the middle projection of the epitrochlea, to bring it out half an inch below the projection of the epicondyle.[1]

Fig. 875.



Circular amputation at the elbow.

Fig. 876.



Flap amputation at the elbow.

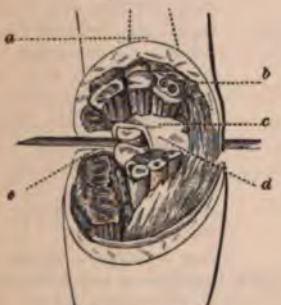
---

[1] J. F. Malgaigne.

The circular method is as follows: The arm being held in a supine position make a circular incision through the skin only, three to four inches below the joint; dissect up the integuments to the joint, and reflect backwards, *a*, *b* (Fig. 875); divide the muscles in front, and the ligaments, enter the joint, and complete the disarticulation by dividing the triceps, or sawing off the olecranon; the brachial artery is divided above its bifurcation.

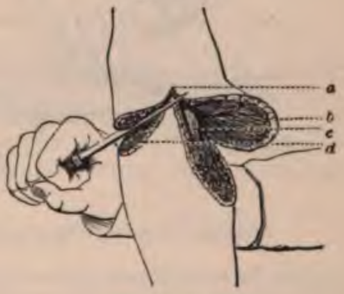
The single anterior flap is made thus: Supinate and slightly flex the limb; raise the soft parts from the bone in front of the joint, enter a straight knife an inch below the internal condyle, traverse the limb close to the ulna, until it appears one and three-quarter inches below the external condyle, to allow for retraction of muscles arising from the humerus; cut an inferior flap, *a*, *b*, *c* (Fig. 876), about three inches in length; retract this flap, *a* (Fig. 877), and pass the knife behind the limb, and enter the heel on the outside between the radius and os brachii, *e*, and extend the incision, draw it across the back part of the joint, dividing all the tissues to the internal angle of the wound; divide the anterior ligament, *c*, *d* (Fig. 877), and the lateral ligaments, luxate the bones forwards, cut the triceps and complete the operation.

Fig. 877.



Flap amputation.

Fig. 878.



External flap.

An external flap may be preferred in some cases of accident:[1] Make the flap by transfixing the limb upon the outside, entering the point of the knife just within the head of the radius, *a* (Fig. 878), traversing the neck, *c*, and cutting out a larger external flap, *b*; a second flap is made from the inside of the arm, by cutting from without inwards, and from below upwards, *d*; the soft tissues immediately covering the joint are divided, and disarticulation completed; a good covering is thus made for the condyles.

IV. AMPUTATION OF THE ARM.

Amputation of the arm may be performed at any point, but, as a rule, as little should be sacrificed as possible. Owing to its uniform size, and single central bone, any of the different methods may be applied, but the periosteum should always be raised, as a covering to the bone.

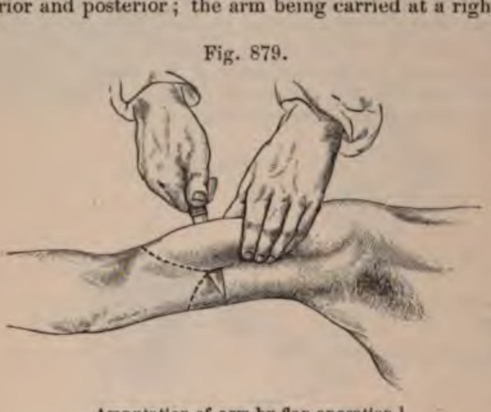
The humerus is covered in its lower part by muscles closely attached; in the upper part large muscles are inserted into it, which have their origin from the thorax, shoulder, and back, which, when divided, tend to retract and leave the bone bare; the only artery always requiring the ligature is the brachial.

---

[1] A. Guérin.

The circular is as follows: Place the arm at right angles to the body; standing on the right side of the limb, make a circular incision through the integuments; roll the flap one to two inches, according to the size of the limb; make a second incision at the margin of the retracted skin; divide and retract the superficial muscles, and make a third incision down to the bone; raise the periosteum an inch, and saw the bone; secure the brachial artery which lies on the inside, between the biceps and internal portion of the triceps muscles; cleanse the wound, and bring the edges together from before backwards; it may be closed from side to side, or even obliquely.

Fig. 879.



Amputation of arm by flap operation.[1]

The flap may be single and may be made at any point presenting on one surface a sufficient amount of tissues; two flaps of equal size are generally anterior and posterior; the arm being carried at a right angle with the body, grasp with the left hand the tissues on the anterior or lateral part of the arm, and passing the knife down to the bone, carry it over to the opposite side, and cut out a flap three-fourths the diameter of the limb in length (Fig. 879), enter the knife close to the bone on the opposite side, and make a similar flap; firmly retract the flaps, divide the tissues covering the bone, and saw the bone in the highest point between the flaps. If one flap is formed, grasp the tissues on the anterior part of the limb, placing the thumb and index finger at opposite points; with the left hand above the place of operation, fix the heel of the knife at the point of the fingers, on the opposite side of the limb, and with a slight downward curve bring it over to the point of the thumb, dividing with one stroke the tissues to the bone; withdraw the knife until the point rests in the angle of the wound, then thrust it under and close to the bone, taking care that the point emerges at the angle of the first cut on the opposite side where the incision commenced; make a flap of sufficient length to cover the stump; divide the remaining soft parts with a circular incision, and saw the bone in the line of division.

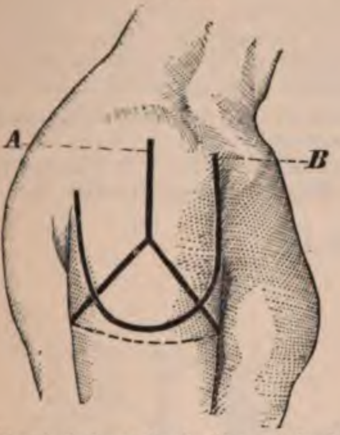
V. AMPUTATION AT THE SHOULDER-JOINT.

The shoulder-joint may be disarticulated by several methods (Figs. 880, 881). This joint is arthrodial; the articular head of the os brachii is very broad, and articulates by scarcely one-third with the shallow glenoid cavity of the scapula; it is connected, too, by a loose capsular ligament; the joint is strengthened by the long head of the biceps, and the muscles arising from the scapula and inserted in the vicinity of the joint; the joint is protected above by the extremity of the clavicle, and the acromion process. The artery must be compressed on the first rib with the thumb or a padded key above the clavicle; or the elastic tube may be applied through the axilla and over the shoulder.

---

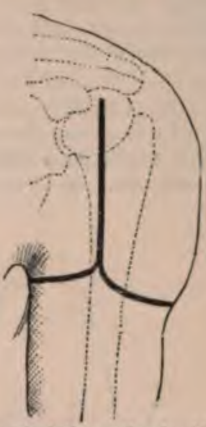
[1] T. Bryant.

Fig. 880.



Disarticulation at the shoulder. *A.* Oval method. *B.* Method by double flaps.

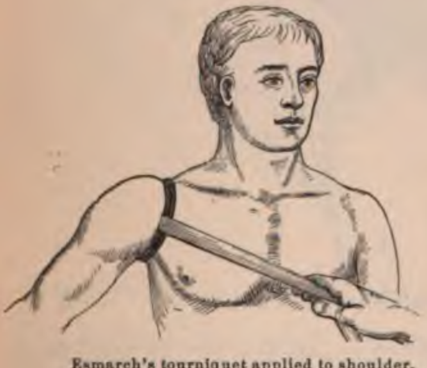
Fig. 881.



Disarticulation at the shoulder. Spence's method.

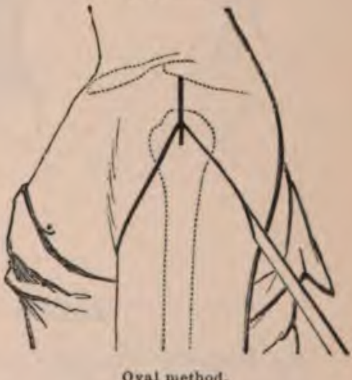
The oval method[1] is well adapted to cases of fracture near the joint. Make a vertical incision from the edge of the acromion process to a point one inch below the top of the humerus down to the bone (Fig. 883). Make two oblique incisions starting from the middle of the vertical one on the anterior, the other on the posterior aspect of the joint, carrying them through the tissues composing the anterior and posterior walls of the axilla, to the lower border of each, and dividing their attachments to the humerus. Push the edges of wound on either side to expose the joint, and open it, making traction on the bone to put its ligament on stretch; luxate the bone, pass the knife behind it and finish the operation by cutting directly through the

Fig. 882.



Esmarch's tourniquet applied to shoulder.

Fig. 883.



Oval method.

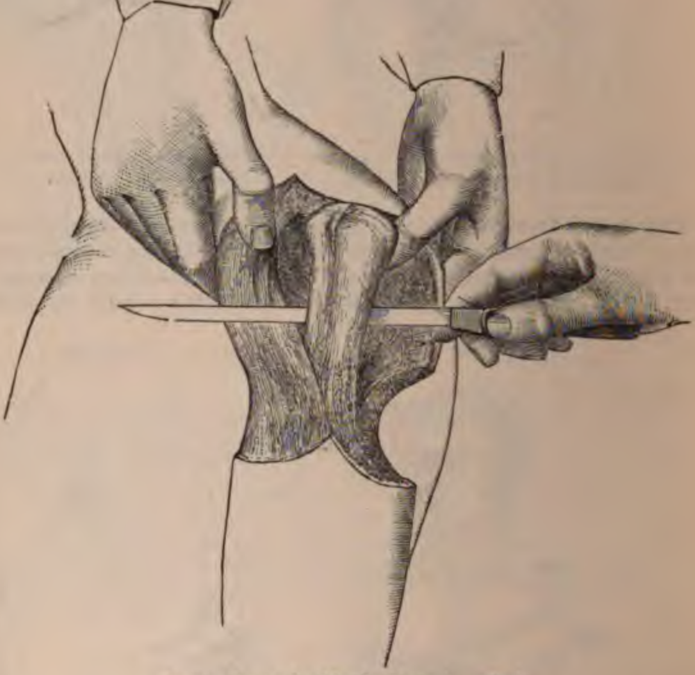
---

[1] Larrey.

tissues in the axilla which intervene between the extremities of the incisions already made, recollecting that they contain the artery, which requires to be compressed by an assistant. The wound which results from this operation is almost perfectly oval in shape. Or, the head of the bone may be dissected from its cavity, with the knife held vertically, first upon one side and then upon the other, and completed by dividing the axillary portion.[1]

The modified oval operation (Fig. 881)[2] is adapted to gunshot wounds. It is as follows: Slightly abduct the arm, and rotate the humerus outwards; commence an incision just external to the coracoid process, and carry it down through the clavicular fibres of the deltoid and pectoralis major muscles, to the humeral attachments of the latter muscle, which must be divided; then carry the incision across and through the lower fibres of the deltoid towards, but not through, the posterior border of the axilla; next carry an incision through the skin and fat only from the point where the straight incision terminated, across the inside of the arm, to meet the incision at the outer part. If the fibres of the deltoid have been thoroughly divided, the flap, together with the posterior circumflex artery, can

Fig. 884.



Amputation at shoulder by Spence's method.

---

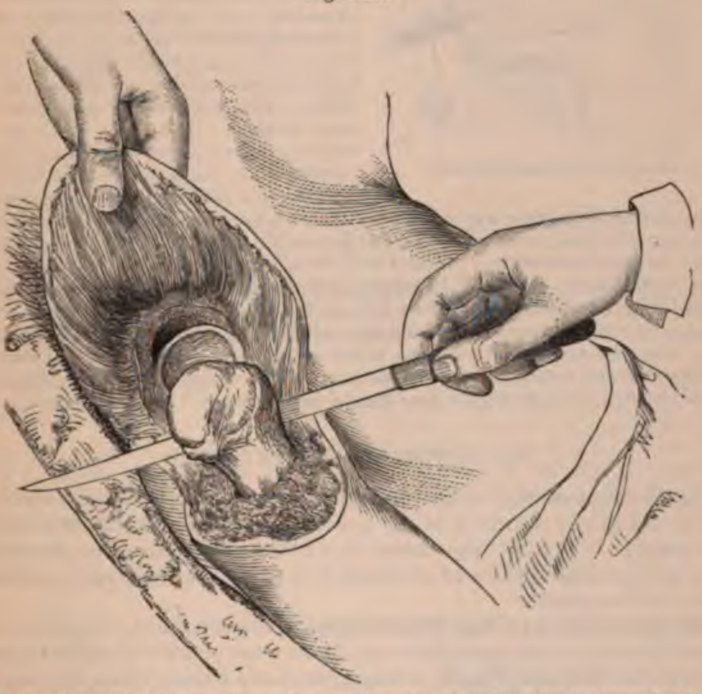
[1] Guérin.

[2] J. Spence.

be easily separated by the point of the finger from the bone and joint, and drawn upward and backward, so as to expose the head and tuberosities. Now divide the tendinous insertions of the capsular muscles, the long head of the biceps, and the capsule, and disarticulate and divide the remaining attachments. (Fig. 884.)

The single flap method may be followed when there is no fracture (Fig. 885): The arm being held away from the trunk, grasp the deltoid in its entire length and thickness in the left hand; and with the right pass a double-edged knife through its base, under the acromion, and grazing the surface of the humerus, cut an external and superior flap of sufficient extent; an assistant raises it; then, by approaching the arm to the body, expose the tendons of the muscles inserted into the head of the humerus and cut them; grasping the arm with the left hand, dislocate the head of the bone outwards, pass the knife behind it and incise the soft parts, while an assistant seizes the flap in such a manner as to prevent hemorrhage from the divided axillary artery, and, if the tissues are hardened, taking care not to allow air to enter the veins.[2]

Fig. 885.



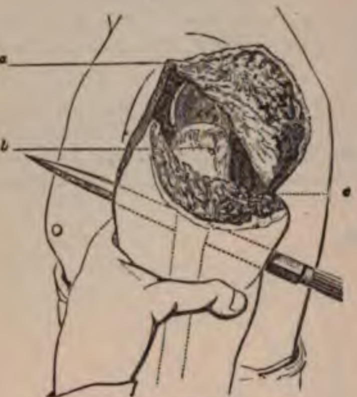
Amputation at the shoulder-joint. Opening the capsule, and making the inner flap.[1]

The double flap[3] is as follows: The arm is kept close to the trunk, the head of the humerus being pushed upwards and outwards as much as possible; recognize the exact position of the acromion and coracoid processes; on the left

---

[1] J. E. Erichsen. [2] S. D. Gross. [3] Lisfranc.

Fig. 886.



Amputation of arm at shoulder.

shoulder enter the point of a long knife almost parallel with the humerus at the outer side of the posterior border of the axilla, in front of the tendons of the latissimus dorsi and teres major muscles, *c* (Fig. 886). As the knife passes in the plane of its blade it should form an angle of thirty-five degrees with the axis of the shoulder, and its point should graze the posterior and external surface of the humerus, until it reaches the under surface of the acromion; at this point the handle of the knife should be raised, and its point lowered so that it is brought out below and in front of the clavicle, *a*, in the triangular space between the acromion and coracoid processes, which is bounded posteriorly by the clavicle. Make the knife cut its way outwards around the head of the humerus, *b*, and as soon as it becomes disengaged from beneath the acromion process, carry the arm away from the trunk; now grasp the deltoid muscle with the left hand, raising it as much as possible from the bone, and carry the knife directly downwards, grazing the bone, and cut out a semicircular flap about three inches in length. In making this flap the upper part of the capsule of the joint should be divided as well as the tendons of the latissimus dorsi, teres major and minor, and part of the deltoid; raise the head of the humerus from the glenoid cavity, pass the blade of the knife behind it, and carry it downwards and forwards, grazing the humerus, to cut out the internal flap, and at this moment the axillary artery should be compressed by an assistant.

VI. AMPUTATION OF THE FOOT.

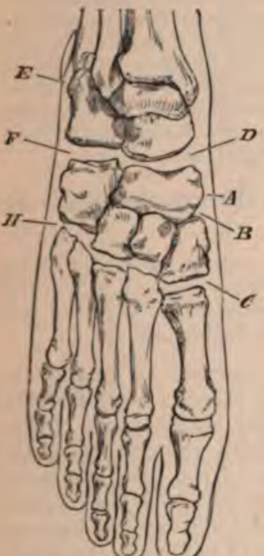
In all amputations of the lower extremity, the surgeon should be governed in the selection of the point of operation and the method to be adopted: (1) By the mortality of the operation in question; (2) By the adaptability of the stump to the most serviceable artificial limb for locomotion.

Amputation of the phalanges in the continuity or contiguity is performed by the same rules as have been given for similar amputations of the fingers; a flap being generally formed from the plantar surface.

Disarticulation of single toes must be undertaken with due regard to the following facts: the extremity of the first metatarsal bone, 1 (Fig. 887), is large, and requires a very liberal flap to cover it; on the plantar surface of the articulation are two or three sesamoid bones; the interarticular line is further from the interdigital fold than in the hand, but the second space is much nearer the joint than the others.

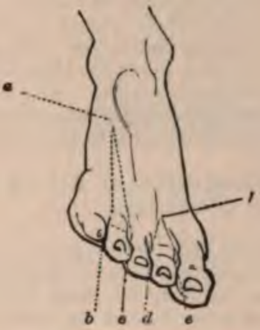
The oval method is as follows: Holding the toe with the finger and thumb, commence an incision over the joint, *f* (Fig. 888), and carry it downwards and forwards, along the side of the toe to the commissure of the toes, around, under the toe, along the transverse linear depression to the opposite side, and thence up to the point of commencement; divide the extensor tendons and lateral ligaments with the point of the knife, open the joint, and complete the disarticulation by cutting the tissues upon the under part of the joint.

Fig. 887.



Surgical guide to foot as expressed by anatomy.

Fig. 888.



Lines of incision.

The single plantar flap, for the second, third, and fourth toes, requires a transverse incision over the joint, and lateral incisions to divide its connections; depress the toe, and pass the knife through the joint and along the under surface of the bone until a sufficient flap is formed. The lateral flap for the great and for the little toe is made thus: Enter the joint by cutting through the commissure, the knife being held vertically, and complete the operation by carrying the knife through the joint and along the outer or inner side of the bone, forming a flap of the requisite size (Figs. 889, 890).

Fig. 889.

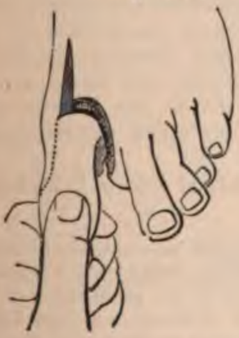
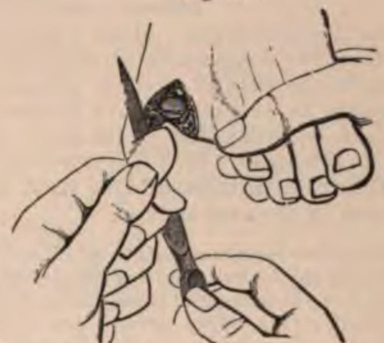


Fig. 890.



Amputation of large and small toes.

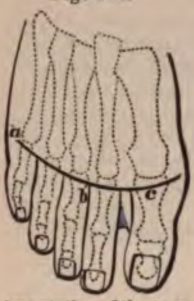
The double flap is thus made: Holding the toe in the left hand, and, recognizing the articulation, transfix the soft parts by passing the knife from the plantar to the dorsal surface on one side, emerging over the middle of the joint, and cutting a flap from the side as far as the edge of the commissure; open the joint on the side, pass the knife through and cut a flap from the opposite side, by passing the knife along the bone; or, the second flap may be cut by transfixing as the first. Or, amputate the toe thus: Bend the toe downwards, and make a dorsal flap across the middle of the phalanx, from the integumental fold, between it and the second toe, to the side of the ball of the first toe, and reflect it; a similar line below, uniting the ends of the first flap by a circular sweep of the knife, forms the lower flap; disarticulate the bone, and complete by cutting out the lower flap. Or, make a straight longitudinal incision along the inner side of the toe, commencing about half an inch behind the articulation, and carry it onwards to the middle of the first phalanx.

Disarticulation of all of the toes is through the metatarso-phalangeal articulations.

These joints (Fig. 887) represent a curved line with its convexity downwards, due to the difference in the metatarsal bones; the second is half a line longer than the first, the third is half a line shorter than the second, the fourth is half a line behind the third, the fifth is still further behind.

The single flap is made in nearly the same manner as in amputation of all the fingers; the incision, *a*, *b*, *c*, in relation to the joints, is seen in Fig. 891. If the operation is on the left foot, grasp the toes with the left hand, the thumb applied to the backs of the toes, and make a semicircular incision in front of the joints, commencing at the internal side of the head of the first metatarsal bone, and ending at the external side of the fifth; dissect up the flap, open the joints, and divide the lateral ligaments with the point of the knife; now pass the knife behind the phalanges and cut a flap from the plantar surface. Or, make the plantar flap by extending an excision along the cutaneous fold at the base of the phalanges and dissecting backwards (Fig. 892).[1]

Fig. 891.



Amputation of the toes.

Amputation through the metatarsal bones is performed with plantar and dorsal flaps, as on the metacarpus. Make a curved incision on the dorsum of the foot, convex downwards, dividing the soft parts down to the bone; transfix the plantar surface, grazing the bones, and make a flap reaching to the commissure of the toes; divide the interosseous muscles with the point of the knife, apply a six-tailed retractor, and divide the bones with a fine saw (Fig. 893).

Disarticulation of the first metatarsal bone is best performed by the oval method.

It has four ligaments, an internal, dorsal, plantar, and interosseous; the articulation is one or two lines behind the first projection found on the posterior portion of the metatarsal bone, and an inch anterior to the prominence of the scaphoid, *e* (Fig. 887); the direction of the line of articulation is from within forwards and outwards; the dorsalis pedis artery passes to the sole of the foot on the outer side of the joint.

---

[1] Guérin.

Fig. 892.

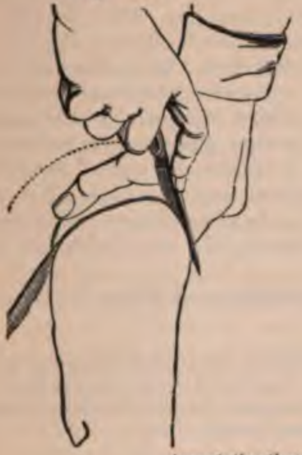
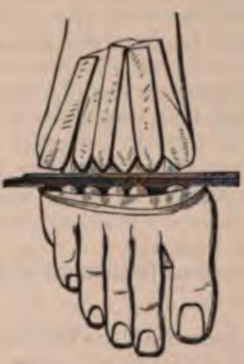


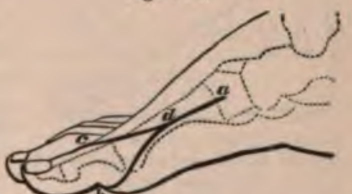
Fig. 893.



Amputation through the metacarpal bones.

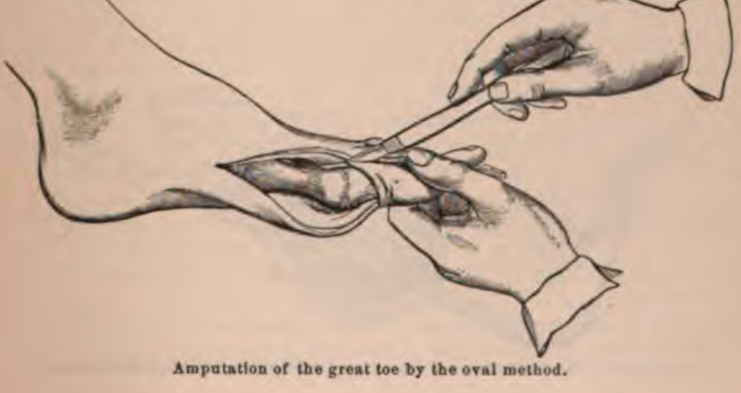
Commence two lines behind the joint, *a* (Fig. 894), an incision directed obliquely from within outward, to the commissure of the toes, *c*, and pass around the base of the first phalanx, following the crease on its plantar surface; withdraw the bistoury and replace it on the internal side of the phalanx, *b*, in the inferior angle of the incision, ascend on the internal side of the metatarsal bone and phalanx, and following a line slightly oblique from within outwards, rejoin the point of commencement; the skin being cut, divide successively in the whole extent of

Fig. 894.



Incision for removal of great toe and metatarsal bone.

Fig. 895.



Amputation of the great toe by the oval method.

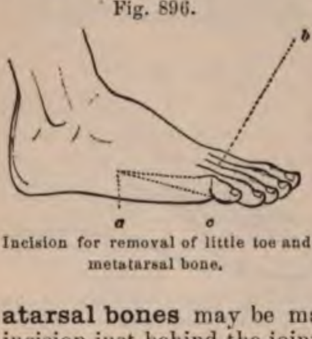
the incision the extensor tendons of the toe and fibres of the dorsal interosseous muscle. Dissect out the bone (Fig. 895), leaving the sesamoid bones in the phalangeal articulation, divide the internal ligament, holding the point of the instrument perpendicularly and the edge slightly oblique from within outwards and from behind forwards to follow the direction of the joint; next, divide the superior ligament, and direct the bistoury upwards and push its point at an angle of forty-five degrees into the interosseous space formed by the external surface of the first cuneiform and the extremity of the second metatarsal bone; when the point has penetrated to the plantar layer, raise the blade again to the perpendicular and divide the interosseous ligament.

Disarticulation of the fifth metatarsal bone is by the oval method.

This bone articulates with the cuboid, *f* (Fig. 887), by a triangular surface, and with the fourth metacarpal; it has a tubercle on the external part of its base, which is easily felt and into which is inserted the peroneus brevis muscle; the line of the articulation is obliquely forwards and inwards.

Commence an incision just behind the joint, *a* (Fig. 896), carry it forwards towards the commissure, *b*, thence under the toe, along the transverse linear depression to the opposite side, *c*, and then along the external margin to *a*, the point of departure; dissect (Fig. 897) the soft parts from the bone and enter the joint found just behind the tubercle; from the outside divide the ligaments which unite it to the fourth metatarsal, and complete the operation by dividing the plantar ligaments.

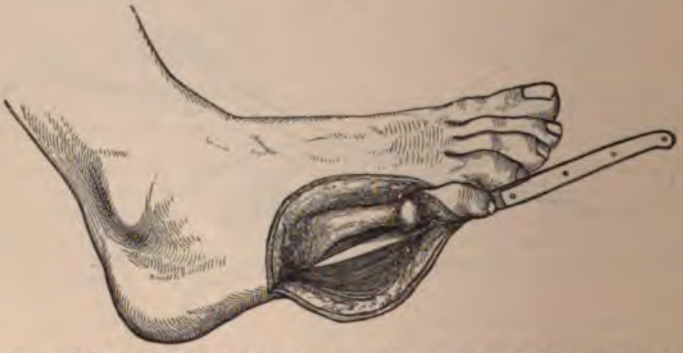
Fig. 896.



Incision for removal of little toe and metatarsal bone.

Disarticulation of single metatarsal bones may be made by the oval method. Commence an incision just behind the joint, *a* (Fig. 894), carry it forwards towards

Fig. 897.

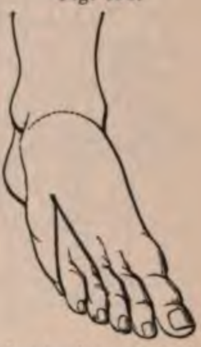


Amputation of the little toe and its metatarsal bone by the racket-shaped incision.

the commissure, *c*, thence under the toe along the transverse linear depression to the opposite side, *b*, and terminate at *a*, the point of beginning; dissect the soft parts from the bone and cut the ligaments uniting it to the third and fifth metatarsal and cuboid, and complete by dividing the plantar ligaments.

Disarticulation of the two outer metatarsal bones is made as follows: Commence an incision a finger's breadth behind the joint of the fifth metatarsal bone, in the middle, between the articulation of the two bones; carry it forwards to the commissure, then along the under surface in the transverse line to the outer side of the little toe, and thence back to the beginning; dissect the soft parts from the bones, divide the lateral ligament, and disarticulate the joints by entering them from the outside, and following the line above given (Fig. 898).

Fig. 898.



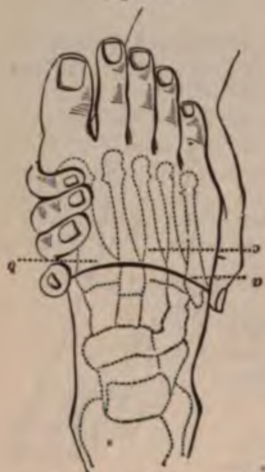
Incision for removal of two toes.

Disarticulation at the tarso-metatarsal articulation, Hey's operation, is effected as follows: First recognize the exact line of the articulation.

On the inner side of the foot just posterior to the projection on the base of the first metatarsal bone, or one inch anterior to the prominence of the scaphoid *A* (Fig. 887), on the outer margin of the foot, the finger readily detects the prominence of the posterior part of the metatarsal bone, immediately behind which is the articulation. Care should be taken not to overlook the slight tubercle at the base of the first metatarsal bone, and not to mistake it for the prominence of the cuneiform bone.

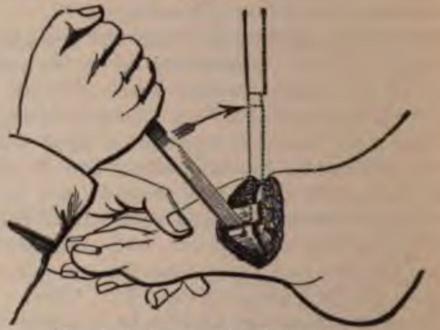
Rotate the foot moderately inwards; recognize exactly the line of the articulation—the internal extremity of which is nine lines further forwards than the external—by the rules already laid down; grasp the foot with the left hand, placing the thumb on the outer side of the proximal end of the fifth metatarsal bone, *a* (Fig. 899), and the index finger at the internal extremity of the articulation, *b*; make a semilunar incision with its convexity looking downwards, from without inwards, across the dorsum of the foot, passing about half an inch below the articulation down to the bones; divide the dorsal ligaments with the point of the knife, carrying it along the line of the articulation from without inwards, recollecting that the articulation of the second metatarsal lies four lines behind the first and third; this mortise, containing the head of the second metatarsal, is opened by entering the knife between the internal cuneiform and the head of the first, its edge being turned upwards and making an angle of forty-five degrees with the axis of the foot (Fig. 900); now carry the knife up to a right angle, its point traversing the whole of the inner surface of the mortise, in order to insure the division of the interosseous ligament; then divide that on outer surface, depress the metatarsus to separate the articular surfaces, and divide the remaining ligamentous attachments, especially on the plantar aspect of the articulation, so that the knife may be readily carried beneath the heads of the metatarsal bones; cut out a flap somewhat larger at its internal than at its external part from the sole of the foot (Fig. 901), and extending internally nearly to the base of the great toe; externally it may be of less extent. Do not include the sesamoid bones in the flap.

Fig. 899.



Points of incision for removal of foot at tarso-metatarsal articulation.

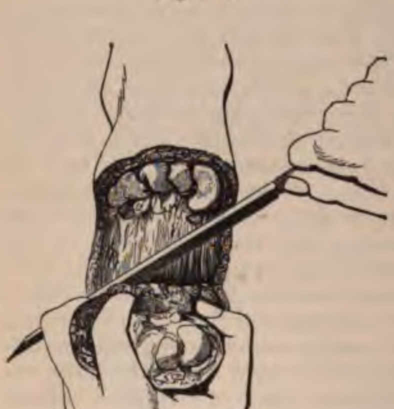
Fig. 900.



Disarticulating second metacarpal joint.

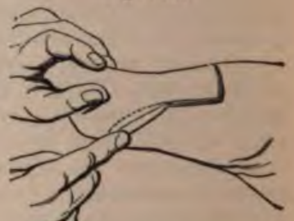
Or, a plantar flap may be made by carrying a curved incision from the internal extremity of the dorsal incision (Fig. 902) to the sesamoid bones, then curving forward across the sole of the foot to the junction of the anterior, with the middle third of the fifth metatarsal bone, thence to the beginning of the dorsal incision. The stump after this operation is useful (Fig. 903).

Fig. 901.



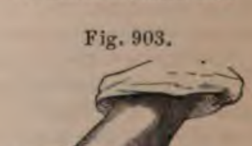
Plantar flap.

Fig. 902.



Formation of plantar flap.

Fig. 903.

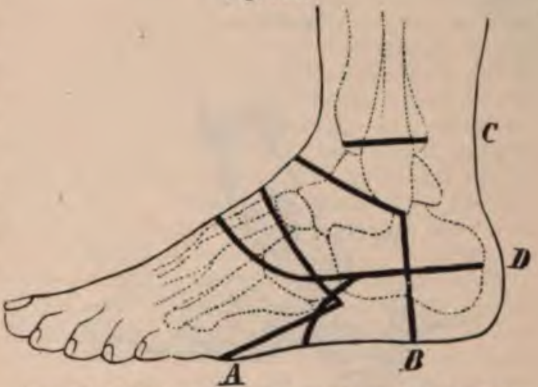


Stump after amputation.

Disarticulation, medio-tarsal, is still approved and performed by many surgeons (Figs. 904, 905).

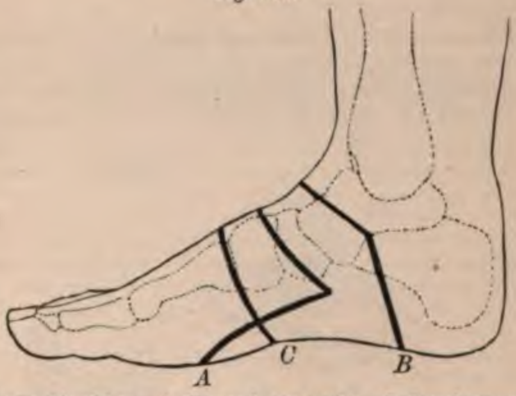
The line of articulation *D* (Fig. 887) is determined as follows: (1) On the internal side of the foot it lies one inch in front of the internal malleolus; or, the first tuberosity in front of the internal malleolus is that of the scaphoid, and the joint is just behind it. (2) On the external side it is six lines behind the prominence of the fifth metatarsal bone; or, it is in front of the first tuberosity anterior to the external malleolus, which is on the os calcis. (3) The centre of the articulation is immediately in front of the head of the astragalus, which is made prominent by extending and abducting the foot. The line of the articulation is changed according as the foot is flexed or extended; when it is flexed, the astragalus and calcaneum are almost on the same line; when extended, the calcaneum is at least three lines in front.

Fig. 904.



Outer side of foot. *A.* Chopart's amputation. *B.* Syme's amputation. *C.* Line of section of bone in Syme's amputation. *D.* Subastragaloid amputation.

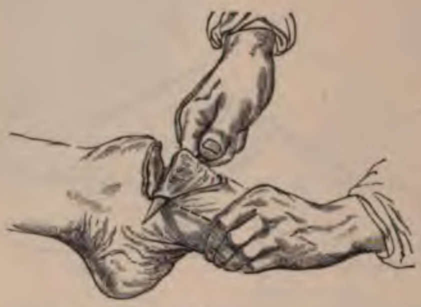
Fig. 905.



Inner side of foot. *A.* Chopart's amputation. *B.* Syme's amputation. *C.* Subastragaloid amputation.

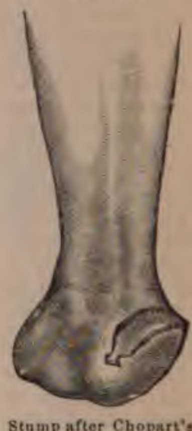
Operate thus: Holding the foot (left) in the hand, place the thumb on the outside of the joint and the index or medius, on the tuberosity of the scaphoid; make a semilunar incision between these two points, the middle of which is half an inch beyond the articulation; then, passing the heel of the knife under the left thumb, its handle inclined as above, open the joint in the direction pointed out; when the joint is half opened, carry the knife in front of the hand of the astragalus, cut the dorsal ligaments without penetrating between the bones; and, lastly, carrying the knife to the other side of the foot, the heel inclined towards the toes at an angle of forty-five degrees, finish opening the external side of the joint; the dorsal ligaments being thus divided, push the point of the knife under the external and anterior side of the astragalus, with its edge directed forwards, and cut the interosseous ligament in the direction of the articular surface of the calcaneum; the joint is now wide open; carry the knife under the plantar ligaments, and pass it under the bones, grazing them, to cut a sufficient flap (Fig. 906), avoiding the protuberances of the cuboid and scaphoid, and further on, of the first and fifth metacarpal bones; the foot during this time is held in the horizontal position; raise the handle of the knife slightly, to follow more exactly the concavity of the tarsus and metatarsus.

Fig. 906.



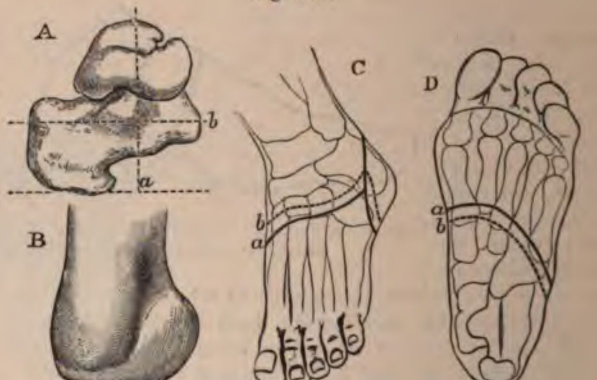
Chopart's amputation.

Fig. 907.



Stump after Chopart's amputation.

Fig. 908.



Tripler's operation of the foot.[1]

Disarticulation of the tarsus under the astragalus has been practised, but is not to be preferred to amputation of the ankle-joint, except in very rare cases. It may be performed as follows:—

---

[1] T. Bryant.

Commence at the outer edge of the tendo Achillis on a level with the external malleolus, *C* (Fig. 908),[1] and make an incision through the skin, first downward and forward, then forward two fingers' breadth below the malleolus, to within a finger's breadth of the upper part of the base of the fifth metatarsal bone; now carry the incision upward, forward, and inward, so as to reach the inner margin of the tendon of the extensor proprius pollicis just behind the first metatarsal articulation; now cut downwards and forwards, and enter the sole, a finger's breadth in front of the dorsal wound; next, carry the incision with a gentle forward curve, outward and backward, until it can be made continuous with the first portion of the wound below the outer malleolus, *D* (Fig. 908). Retract the integument half an inch, and divide the dorsal and plantar structures to the bone and separate them from the bones, great care being taken to preserve uninjured the vessels contained in the inner part of the plantar flap; now disarticulate the cuboid and scaphoid from the astragalus and os calcis, separate the periosteum from the under surface and posterior extremity of the os calcis to a level of the sustentaculum tali; saw the bone through in a direction from behind and within, forwards and outwards, so as to leave a surface which will be at right angles with the axis of the tibia when the limb assumes the position for walking or standing, *A* (Fig. 908). Remove all sharp edges and angles, divide the posterior tibial nerve high in the flap, secure vessels, insert drains, close the wound, and fix the part in the position of slight flexion. The stump, *B*, is good and useful.

Or, commence an incision on the posterior and external face of the calcaneum, and carry it forward below the external malleolus to a point half an inch anterior to the articulation of the astragalus in front; then carry it to the internal border of the foot, and from thence obliquely backwards across the plantar surface to the point of departure; the flap is thus made from the entire integument of the heel. Or,[2] commence the incision at about the same point, and carry it forward within an inch of the posterior and internal extremity of the fifth metatarsal bone, thence with a downward curve across the dorsum of the foot to the middle of the internal cuneiform bone, thence across the sole of the foot from within outwards, and from before backwards to the commencement. Or,[3] make the same incision until it reaches the internal border of the foot; then carry it transversely across the plantar surface to the posterior extremity of the fifth metatarsal, then backwards and obliquely upwards along the external surface of the foot to the point of departure. It may be reversed, passing in the opposite direction, under the foot, from the external to the internal side. In the dissection care should be taken to avoid injuring bloodvessels high in the flap by turning the edge of the knife to the bone.

VII. AMPUTATION AT THE ANKLE-JOINT.

Disarticulation of the ankle-joint, *B* (Figs. 909 and 910), with a heel-flap,[4] has justly been regarded as one of the greatest improvements in amputation of modern times.[5] Not only is the mortality of this operation very small, but when compared with the stumps made at any other point of the foot or leg, those made at the ankle-joint have proven eminently superior and gratifying to the patient; they have been less subject to those untoward complications and sequelæ, as ulcers, congestions, necrosis, and chronic tenderness, which impair subsequent usefulness with appropriate and well-adapted compensative apparatus.[1]

---

[1] Tripier.

[2] L. Verneuil.

[3] E. Nélaton.

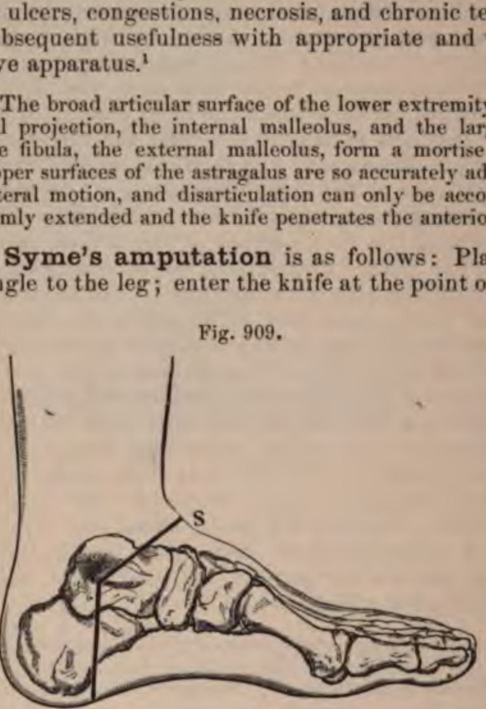
[4] J. Syme.

[5] Sir W. Fergusson.

The broad articular surface of the lower extremity of the tibia with its internal projection, the internal malleolus, and the large projecting extremity of the fibula, the external malleolus, form a mortise to which the lateral and upper surfaces of the astragalus are so accurately adapted that there can be no lateral motion, and disarticulation can only be accomplished when the foot is firmly extended and the knife penetrates the anterior part of the articulation.

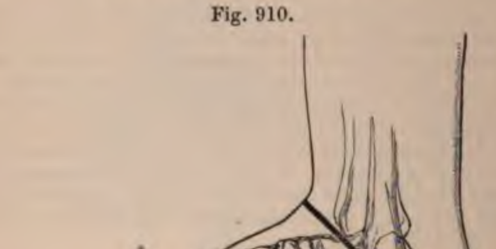
Syme's amputation is as follows: Place the foot at the right angle to the leg; enter the knife at the point of the external malleolus, and carry it directly across the sole of the foot (Fig. 909) to a point opposite, or six lines below the internal malleolus (Fig. 910); the posterior tibial artery divides beneath the internal annular ligament into the internal and external plantar arteries, and if the incision extends to the point of the internal malleolus the vessel may be divided;[2] join the two extremities of this incision by an anterior incision in a direct line over the instep, so that the cicatrix may come well in front[3] (Fig. 911). In dissecting the posterior flap, place the fingers of the left hand upon the heel, while the thumb rests upon the edge of the integuments, and then cut between the nail of the thumb and the tuberosity of the os calcis (Fig. 912), so as to avoid lacerating

Fig. 909.



Syme's operation. Inner side of foot.[4]

Fig. 910.



S. Line of incision for Syme's operation. *P.* Line of incision for Pirogoff's operation.[4]

---

[1] E. D. Hudson.

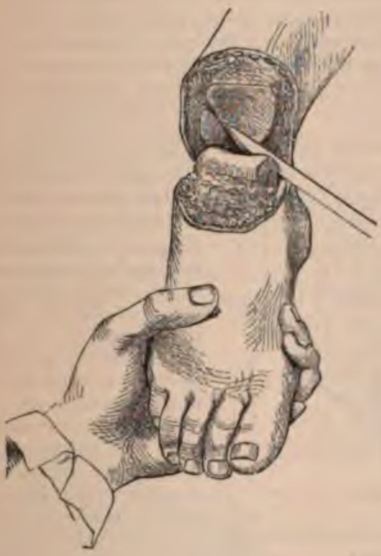
[2] J. A. Wyeth.

[3] McLeod.

[4] J. E. Erichsen.

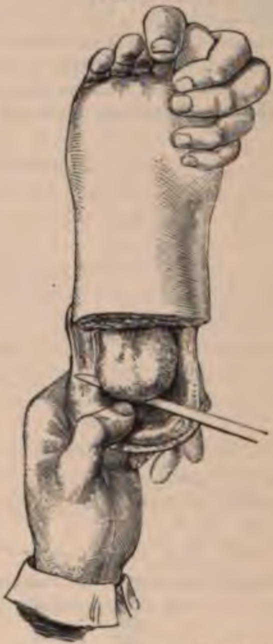
the soft parts, which at the same time are gently but steadily pressed back until the tendo Achillis is exposed and divided. Disarticulate

Fig. 911.



Syme's amputation of the foot. Anterior incision and disarticulation.

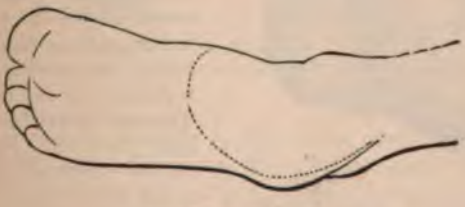
Fig. 912.



Syme's amputation of the foot. Cleaning the os calcis.

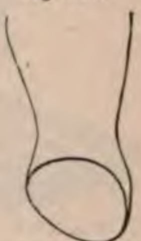
the foot, and saw off the malleoli obliquely; leave the article extremity of the tibia uninjured, for it is better not to interfere with the bone if it is healthy.[1]

Fig. 913.



Mackenzie's method.

Fig. 914.



Roux's method.

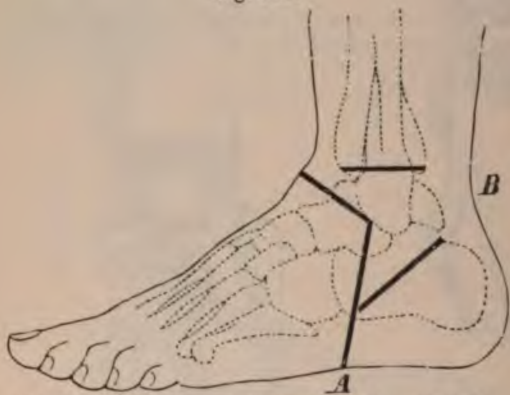
There are many methods of modifying the construction of flaps to cover the ends of the tibia and fibula, adapted to the various forms of injury of the soft parts; all coverings, whether from the sole, the lateral surfaces, or from the dorsum of the foot, are useful, and should be preserved for that purpose when the heel-flap is wanting. The following examples illustrate other forms of flap:—

---

[1] McLeod.

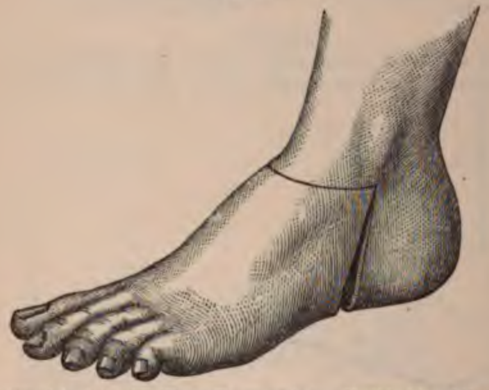
In the first example enter a knife in the mesial line of the posterior aspect of the ankle, on a level with the articulation, carry it downwards obliquely across the tendo Achillis towards the external border of the plantar aspect of the heel, along which it is continued in a semilunar direction; curve the incision across the sole of the foot, and terminate it on the inner side of the tendon of the tibialis anticus, about an inch in front of the inner malleolus; carry the second incision across the outer aspect of the ankle in a semilunar direction, between the extremities of the first incisions, the convexity of the incision downwards (Fig. 913), and passing half an inch below the external malleolus. Or, make an incision from the junction of the tendo Achillis with the os calcis around the external surface of the foot, immediately below the external malleolus, then carry it inwards towards the internal border, curve forwards and about an inch in front of the ankle-joint; then pass along the internal border of the foot to the point of departure. The stump (Fig. 914) is very useful.

Fig. 915.



Pirogoff's amputation. *A*. Cutaneous incision, outer side. *B*. Line of section of the bones.[1]

Fig. 916.



Line of incision for Pirogoff's operation. Modified by oblique section of the os calcis.[1]

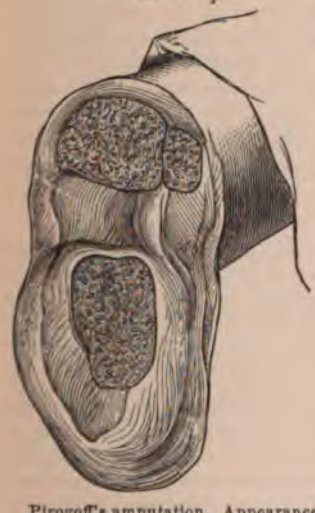
Osteoplastic amputation at the ankle-joint[2] (Fig. 915) provides a covering of the stump consisting of the posterior part of the os calcis, with the integument of the heel. The results are favorable, but the additional length of limb is not desirable for an artificial limb.[3] Commence the incision close in front of the outer malleolus, carry it vertically downwards to the sole of the foot (Fig. 916), then transversely across the sole, and lastly obliquely upwards to the inner malleolus; terminate it a couple of lines anterior to the malleolus now; divide all the soft parts at once quite down to the os calcis; now connect the outer and inner extremity of this first incision by a second semilunar incision, the convexity of which looks forward, carried a few lines anterior to the tibio-tarsal articulation; cut through all the soft parts at once down to the bones, and then proceed to open the joint from the front, cutting through the lateral ligaments, and thus exarticulate the head of the astragalus; now place a small, narrow amputation saw obliquely upon the os calcis behind the astragalus, and saw through the bone carefully, or the anterior surface of the tendo Achillis, which is only covered by a layer of fat and a thin fibrous sheath, may be injured; raise the short anterior flap from the two malleoli, and make a section of the tibia and fibula just above the articular surfaces; turn this flap forwards, and bring the cut surface of the os calcis in apposition with the cut surface of the tibia (Fig. 917); the tendons must not be cut off too near the point where their synovial sheaths are cut through; if cut too short, they conceal themselves in the fibrous canal, or, when the limb is moved, slip upwards out of their sheaths.

---

[1] J. E. Erichsen. [2] Pirogoff. [3] E. D. Hudson.

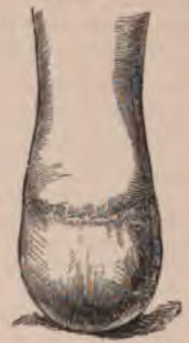
Supra-malleolar amputation is closely allied to ankle-joint disarticulations. It should always be preferred to any operation at a higher point, and the flap should be taken from the firmest tissues accessible. The following method gives a good stump: Make an incision from the base of the external malleolus, posteriorly, around the external surface of the foot immediately below the malleolus, and inwards towards the internal border, but curved forwards to a point an inch in front of the ankle-joint (Fig. 919); make a similar incision on the internal surface and unite the two

Fig. 917.



Pirogoff's amputation. Appearance of the parts after removal of malleoli.[1]

Fig. 918.

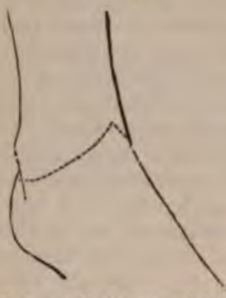


Stump after Pirogoff's amputation.[1]

---

[1] J. E. Erichsen.

Fig. 919.



Supra-malleolar amputation.

behind by a transverse incision, having a slight convexity downwards; separate the soft parts from the bones, and saw the tibia and fibula at the base of the malleoli, about an inch above the articular surface.

VIII. AMPUTATION OF THE LEG.

Amputation of the leg involves new and most important principles both in operative and mechanical surgery. At no other point is it more necessary to secure a sound and useful stump than in this part. This is due to the incessant use to which it must be applied, and its exposure to injury. But it presents intrinsic difficulties in the application of the ordinary methods of amputation. This is apparent in the development of the muscles of the calf, the tapering form of the lower portion, and the subcutaneous position of the tibia. The circular flap cannot be retracted without dividing it longitudinally; the single posterior flap is of immense size, and is counteracted only by the integument of the anterior part of the leg; the double flap gives a great inequality of flaps; the single external flap leaves the crest of the tibia but slightly covered. The results of amputation of the leg have, in consequence of these conditions, been more unsatisfactory than at any other point. Necrosis of the tibia, conical stumps, ulcerated coverings, and tender cicatrices have been the rule, when the old methods have been preferred. But bilateral flaps of the soft parts and periosteal coverings of the tibia give a firm, compact, and enduring stump.

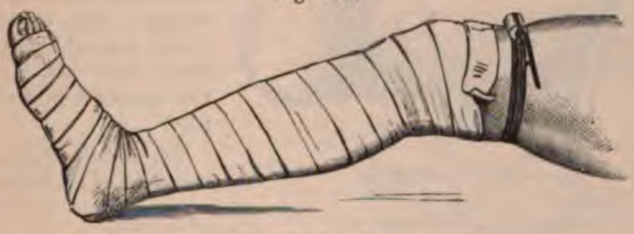
Sufficient data have now been accumulated to establish the comparative and practical advantages of this method. The largest experience in the critical examination of stumps for the purpose of applying compensative apparatus has led to the conclusions[1] that the bilateral method gives: (1) Little ability to exfoliation, necrosis, osteo-myelitis, abscesses, etc. (2) Healthy tone, circulation, quality, and capacity to the stump, with the least amount of muscular retraction and displacement of covering tissues. (3) The terminal axis of the stump constitutes a much better basis of support as conditions may exist; and the leverage retained, be it long or short, affords a most important advantage over every other method, both as regards immediate success, and the ultimate superior usefulness of the stump. The most important immediate advantages are (1) a periosteal covering of the cut end of the bone which aids in preventing necrosis and osteo-myelitis, and insures against an adherent cicatrix of the skin; (2) ample and well-nourished flaps; (3) complete drainage.

The place of division of the bone may be at any point, but at the lower part of the leg the commencement of the calf is most favorable for a symmetrical stump, and at the upper part, a point two inches below the tubercle of the patella, which permits the knee to be bent, and brings the support upon the condyles of the femur. An amputation at the latter point is indicated whenever the leg is permanently flexed, either at a right or at an acute angle with the thigh. If the amputation must be very close to the joint, disarticulation should be preferred, for the risk to the patient of the knee-joint amputation is no greater than of an amputation of the extreme upper third of the leg, while its practical benefits are much superior, as confirmed by experience.[1] The elastic bandage should first be applied to a point above the knee (Fig. 920). The bilateral flap here recommended should be made as follows: Commence an incision with a large scalpel in the centre of the anterior surface (Fig. 921) and carry it downwards along the side of the leg so as to make a slightly curved flap with its convexity below; when the incision passes over the prominent part of the leg towards the posterior surface, incline it upwards until the middle of the limb is reached, where it should be continued directly up to the point at which the bone is to be divided; make a similar incision on the opposite side; these lateral flaps should consist of the skin and superficial fascia; dissect them upward to the extent of one inch in the leg and two inches in the thigh; now make a circular division of the muscles to the bone with a long knife; saw the bone or bones at this point, and direct an assistant to seize and hold the extremity firm with strong forceps (Fig. 843); with the periosteal knife, or the thumb nails, which are equally efficient, raise the periosteum from the tibia to the point where the latter is to be cut; divide the bone at the base of the periosteal flap. The periosteum must be cut at its attachments to the bone and should be raised only from the tibia, the fibula being first exsected. The covering thus prepared has the integument externally, the periosteum internally, while the intervening tissues, muscles, vessels, nerves, have not been disturbed in the dissection; the periosteal flap falls like a hood over the end of the bone (Fig. 922), the skin flaps lie in contact without

---

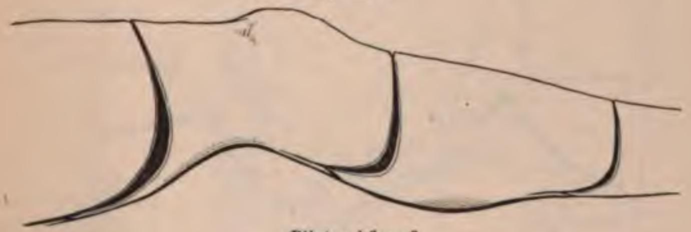
[1] E. D. Hudson.

Fig. 920.



Esmarch's method for bloodless amputation.

Fig. 921.



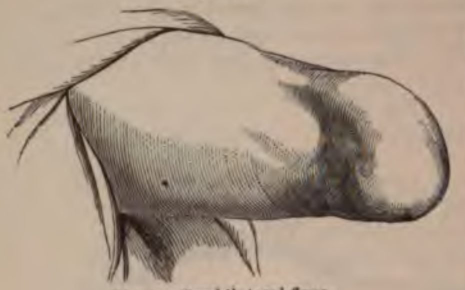
Bilateral flaps.[2]

---

[1] E. D. Hudson.

[2] S. Smith.

Fig. 922.

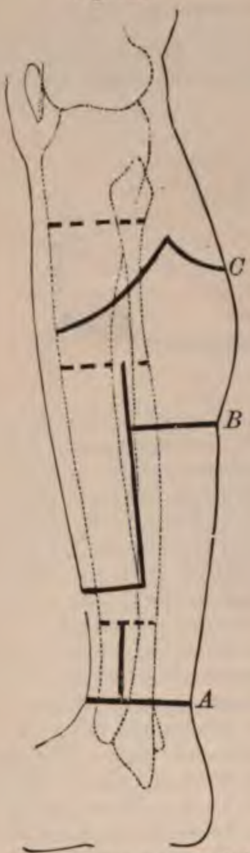


Stump after bilateral flaps.

tension, the drainage is direct from the angle of the wound beneath. When cicatrization is complete, the cicatrix lies posterior to the end of the stump; the cushion is freely movable, and the bone does not undergo the usual amount of atrophy.

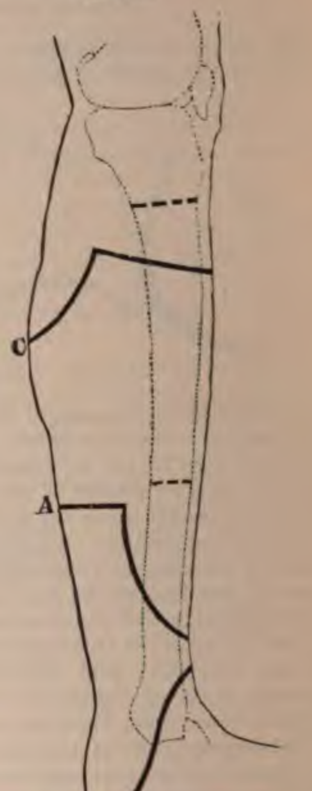
The various other methods of operating are indicated by

Fig. 923.



Amputation of leg. *A*, modified circular; *B*, rectangular flaps;[1] *C*, antero-posterior flaps, upper third.[2]

Fig. 924.



Amputation of leg. *A*, long anterior flap; *B*, supra-malleolar amputation by long posterior flap;[3] *C*, at the upper third.[4]

---

[1] Teale.

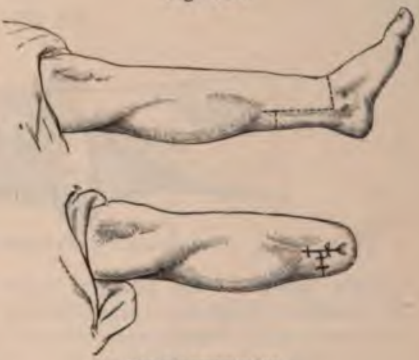
[2] Bell.

[3] Guyon.

[4] Sédillot.

the illustrations (Figs. 923 and 924). The rectangular flap[1] (Fig. 925) is sometimes made in the lower part of the leg; the rules given as to the formation of the flaps in this operation must be strictly observed. The flap operation is very often selected for the upper part of the leg, and is very simple in its details (Fig. 926). Skin flaps and circular of the muscles, the mixed method[2] (Fig. 927) to be preferred to the common flap amputation.

Fig. 925.

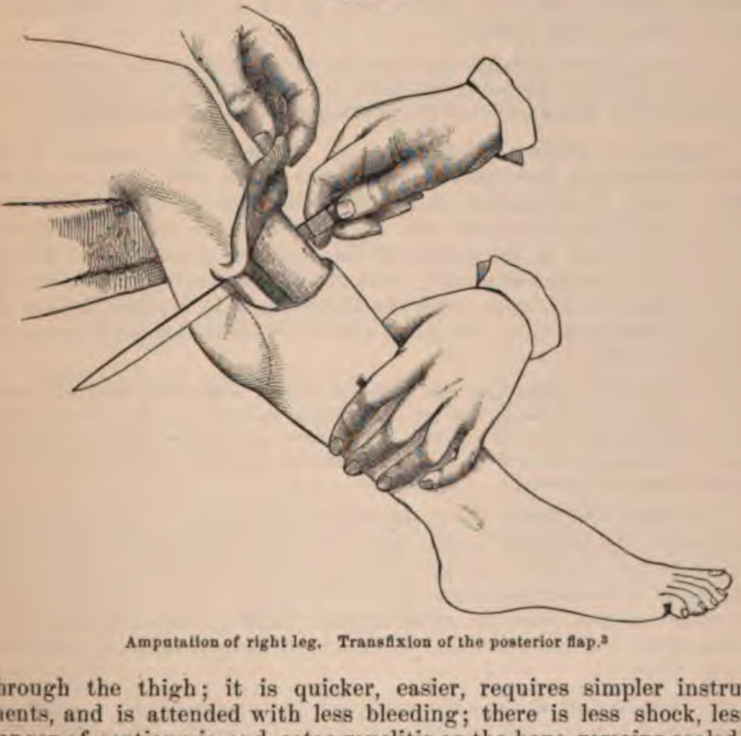


Teale's amputation.

IX. AMPUTATION AT THE KNEE-JOINT.

This amputation now ranks among the most successful operations both for safety and the usefulness of the stump, as compared with amputations through the thigh; it is quicker, easier, requires simpler instruments, and is attended with less bleeding; there is less shock, less danger of septicæmia and osteo-myelitis as the bone remains sealed;

Fig. 926.



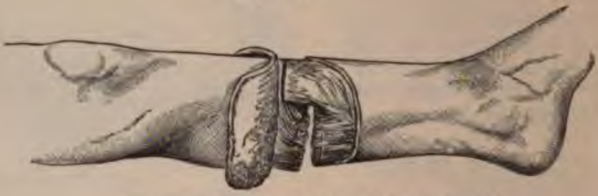
Amputation of right leg. Transfixion of the posterior flap.[3]

---

[1] Teale. [2] T. Bryant. [3] J. E. Erichsen.

the integuments preserved are, as a rule, better adapted to sustain pressure; there is less risk of injury to flaps from a rough-sawn bone; less retraction of muscles; the sustaining power is more quickly acquired; the point of support is broader and better fitted for pressure; from large anastomoses about the joint, the blood supply is more quickly established; the redundant size of the articular head of the femur in time disappears. There are many methods of operating, but the bilateral flap method is to be preferred for the general reasons given; the joint surface of the bone should not be disturbed unless diseased, and the patella may be left in its place, though it is of no value to the stump.

Fig. 927.



Amputation of the leg by the mixed method.[1]

The line of the articulation lies internally nine lines above the prominence of the tibia; the lower border of the patella is on a line with the articulation, and externally it is nine lines below the prominence of the external condyle.

Operate as follows: Select a large scalpel, and commence an incision about one inch below the tubercle of the tibia, and cut to the bone; carry it downward and forward beyond the curve of the side of the leg, thence inwards and backwards to the middle of the leg, thence upwards to the middle of the popliteal space; repeat this incision upon the opposite side; raise the flap, consisting of all the tissues, down to the bone, until the articulation is reached, divide the lateral ligaments, enter the joint, and sever its connections internally and externally.

Care should be taken that the incisions incline moderately forwards, down to the curve of the side of the leg, to secure ample covering for the condyles, and that upon the internal aspect it should have additional fulness for the purpose of insuring sufficient flap for the internal condyle, which is longer and larger than the external.

The flaps completely cover the condyles (Fig. 928), and are readily approximated, leaving ample space for direct drainage at the upper angle of the wound; a drain tube may be inserted, if necessary; the flaps are well nourished and union takes place rapidly, giving a well-rounded stump with the cicatrix sunk in the inter-condyloid fossa (Fig. 922). Other methods of knee-joint amputation are as follows (Fig. 929): —

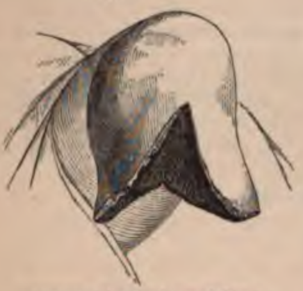
(*a*) **Amputation through the condyles**[2] consists in reflecting a rounded or semi-oval flap of skin and fat from the front of the joint; dividing everything else straight down to the bone; and sawing the bone slightly above the plane

[1] T. Bryant.

[2] Carden.

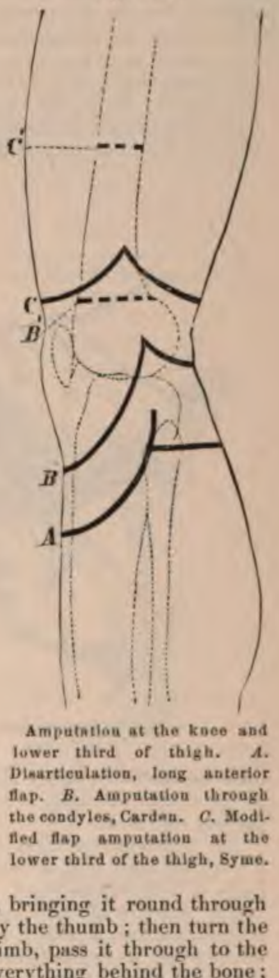
of the muscles; thus forming a flat-faced stump with a bonnet of integument to fall over it (Fig. 930). Standing on the right side of the limb, seize it between the left forefinger and thumb at the points selected for the base of the flap, and enter the point of the knife close to the finger, bringing it round through skin and fat below the patella to the spot pressed by the thumb; then turn the edge downwards at a right angle with the line of limb, pass it through to the spot where it first entered, cut outwards through everything behind the bone; reflect the flap and divide the remainder of the soft parts down to the bone; slightly clear the muscles upwards, and saw the bone. Or, the knife may be brought round under the limb as in the circular operation and the ham cut across by turning the edge of the knife upwards In amputating through the condyles, the patella is drawn down by flexing the knee to a right angle before dividing the soft parts in front of the bone; or, if that be inconvenient, the patella may be reflected downwards.

Fig. 928.



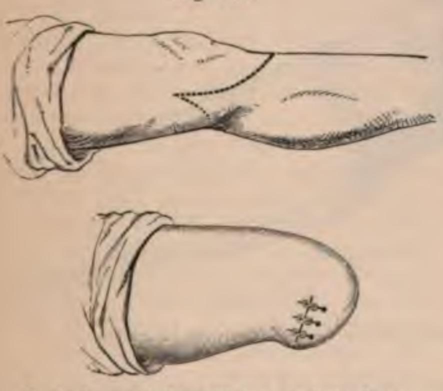
Amputation by lateral flaps.

Fig. 929.



Amputation at the knee and lower third of thigh. *A*. Disarticulation, long anterior flap. *B*. Amputation through the condyles, Carden. *C*. Modified flap amputation at the lower third of the thigh, Syme.

Fig. 930.



Carden's amputation with long posterior flaps.

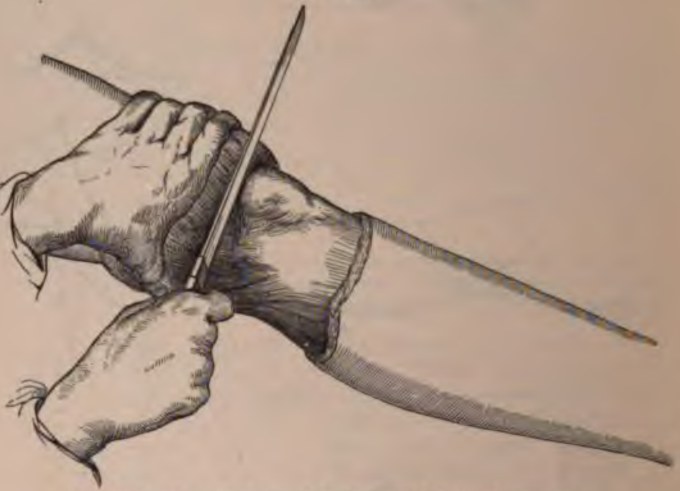
(*b*) **Osteo-plastic amputation of the knee**[1] consists, not only in removing a portion of the condyles, but also of incising the patella *A* (Fig. 935), and placing the cut surface upon the sawn condyles for the purpose of securing union of the bones.

---

[1] Gritti.

(c) **The modified circular method**[1] is as follows: First cut transversely across the front of the limb, from side to side, at the level of the anterior tuberosity of the tibia, and join the horns of this incision by carrying the knife at an angle of forty-five degrees to the axis of the leg through the skin and fat; elevate the limb, dissect up the posterior skin flap, and then proceed to raise the ring of integument as in a circular operation, taking due care to avoid scoring the subcutaneous tissue, and dividing the hamstrings as soon as they are exposed, and bending the knee, the upper border of the patella is exposed; then sink the knife through the insertion of the quadriceps extensor (Fig. 931), and having cleared the bone immediately above the articular cartilage, and holding the limb horizontally, apply the saw vertically and at the same time transversely to the axis of the limb, not the bone, so as to insure a horizontal surface for the patient to rest on.

Fig. 931.



Amputation through the condyles by modified circular method.

The following criticism upon the methods of amputation at the knee-joint by a surgeon who had a very large experience in the application of artificial limbs is very instructive.[2]

The practice of dividing the condyles cannot be sustained by any rational hypothesis, nor practised on any scientific principles; except disease or injury of the condyles compels their excision, their osseous covering and cartilage investments should be kept inviolate from knife and saw, for, as constituted, they are the strongest, most tolerant, and important supports in the entire body; the inter-condyloid fossa is readily filled with a neatly-shaped elastic pad of wool felt, even with the convexity of the condyles, and made to extend over them for a cushion, in the adaptation of prothetic apparatus. Equally reprehensible is the method of placing the patella over the fossa with a view to making that a point of support, and also of sawing off the condyles and applying the patella to the cut surface; these and other ingenious experiments are of no practical value.

[1] J. Lister.

[2] E. D. Hudson.

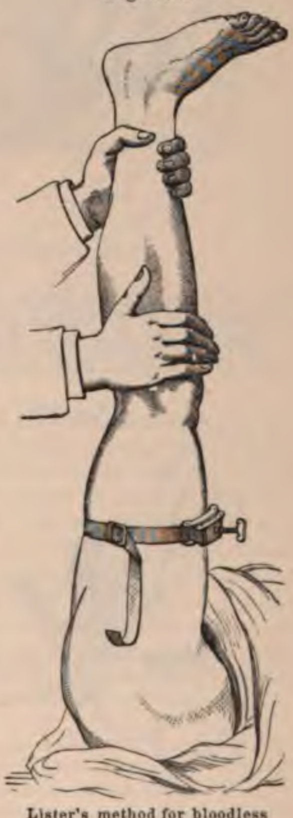
X. AMPUTATION OF THIGH.

The thigh is composed principally of muscular structures, which surround the femur in two distinct layers, the superficial and deep; the superficial muscles all spring from the pelvis and go to the leg, and the lower they are cut the more they retract, and *vice versa*.

It results that nearly the same length of soft part covers the stump at all points; above, on account of the size of the wound; below, to make up for the increased muscular retraction; the posterior part of the femur being almost uncovered by deep muscles, retraction is stronger there than on the other sides, the more so, as the slightly flexed position of the thigh, by stretching the posterior muscles, favors still more their retraction, and leaves them, when cut, of less real length than the others; the same thing takes place, but to a less degree, on the inside, compared with the outside, the latter only offering muscles adherent to the bone, and the muscles on the inside being also extended by abduction; on this account, after circular amputations, the cicatrix is almost constantly behind and inside.[1]

Observation and experience teach that amputations of the thigh, as ordinarily performed, and ultimately treated with prothetic apparatus, are unnecessarily pisabling; but with the bilateral flap and periosteal reserve, and as full length of the femur for leverage as the injury or disease will safely allow, a quality and capacity of stump may be obtained, which, with appropriate, well-adapted apparatus, will assure the patient a firm basis of support on a line with the axis of the thigh; ample leverage, and adequate motor power, enable him to balance his weight exclusively on his artificial limb, and to walk without a cane, with ease and gracefulness.[2] If such an operation should prove a secondary success, and ultimately require partial or entire peripheral support in the adaptation of prothetic apparatus, nothing will have been lost, when compared with the past amputations and their results, and, eventually, much may be gained, as has occurred in many cases of the ordinary modes of operation; as a rule, the most perfect success may reasonably be expected of the bilateral variety of operation, and the pleasing and profitable results experienced, in both civil and military surgery, afford guarantees to the mutilated of the greatest possible amount of benefit, with appropriate apparatus.[2] The method of procedure requires the

Fig. 932.



Lister's method for bloodless amputation.

---

[1] J. F. Malgaigne.

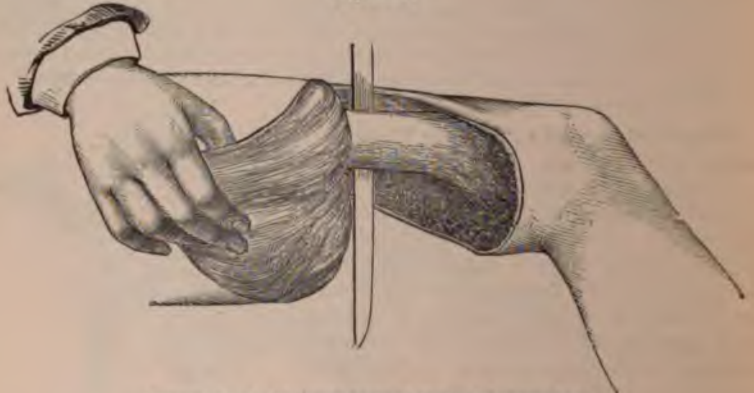
[2] E. D. Hudson.

same incision as the operation on the leg already detailed (Fig. 934).

It is highly important to save all the blood possible, and for this purpose the elastic bandage should first be applied, and carried to the hip where the elastic tourniquet is applied (Fig. 936). Or, the tourniquet may be placed loosely around the thigh, the thigh raised for a few minutes while it is rubbed towards the hip, and then the tourniquet is tightened (Fig. 932).

Lateral flaps are made as follows: Introduce the knife in the centre of the limb, directly down to the bone, on one side of which it is passed to the opposite side of the limb and the flap is then formed (Fig. 933); then introduce the knife and make a flap on the opposite side; strongly retract the flaps and saw the bone at the highest point.

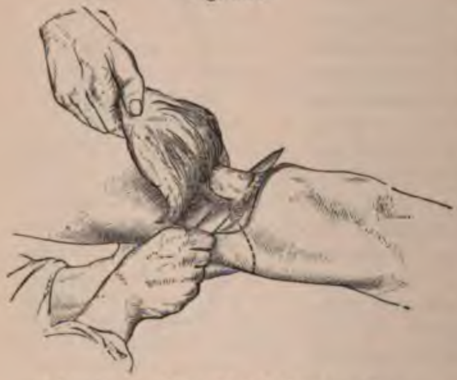
Fig. 933.



Amputation of the lower third of thigh by lateral flaps.[1]

Antero-posterior flaps are made thus: Standing at the right side of the limb, grasp the soft parts and bring them forward; transfix the limb, the knife grazing the upper surface of the bone and make an anterior flap (Fig. 934); reintroduce the knife, and, passing it under the bone, make a posterior flap longer than the anterior, to compensate for the greater retraction; complete the operation, as in the lateral flap method. Another method is as follows: Standing at the right side of the limb, grasp the thigh with the left hand, placing the fingers and thumb on opposite points, apply the heel of a long amputating knife on the further side of the limb at the ends of the fingers, and drawing it in a semicircular direction over

Fig. 934.



Amputation of the thigh by flap operation.

---

[1] J. E. Erichsen.

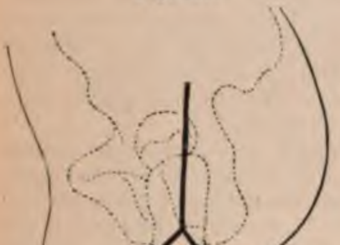
the limb to the end of the thumb, dividing by this single sweep all the soft parts down to the bone; without removing the knife, withdraw it sufficiently to enter the point at the angle of the wound, and transfix the limb, passing under the bone to the angle of the wound on the opposite side; cut a flap of the requisite length from the posterior part of the thigh.

Other methods of operating are seen in Fig. 935.

XI. DISARTICULATION AT THE HIP-JOINT.

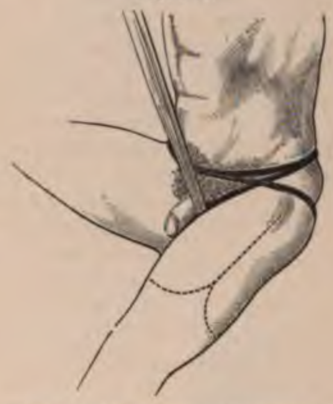
The hip-joint is formed by the head of the femur and the acetabulum, into which it is received; its ligaments are the round ligament, which attaches the head of the bone to the bottom of the cavity, and the capsular ligament surrounding the joint; it is deeply situated under thick and powerful muscles, and can be felt only on the anterior part; it must be recollected that the plane of the margin of the acetabulum inclines downwards and forwards, projecting more posteriorly than anteriorly; the arteries are the femoral, the obturator, the ischiatic, and external and internal circumflex. The following are anatomical guides to the joint:—

Fig. 935.



A. Gritti's amputation at the knee. *A'.* Lines of division of bone. *B.* Long anterior flap.[1] *B'.* Division of bone. *C.* Amputation at lower third.[2] *C'.* Division of bone. *D.* Disarticulation of hip.

Fig. 936.



Arrest of hemorrhage. Operations on the hip-joint. The dotted line is the incision for the oval amputation at the hip-joint.

(1) The anterior inferior spinous process of the ilium is three-quarters of an inch above the superior margin of the acetabulum; the anterior superior spinous process

[1] Sédillot.

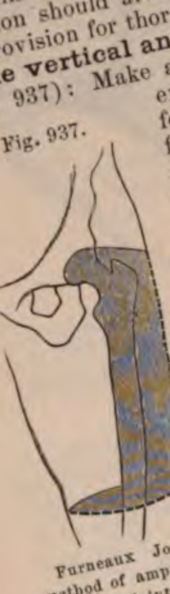
[2] J. Spence.

bout an inch and three-quarters above the same point, and three-quarters an inch to its outer side. (2) The anterior border of the acetabulum is m an inch to an inch and a quarter to the outside of the spine of the bes. (3) The axis of the horizontal ramus of the pubes, extended by an aginary line, crosses the acetabulum at the junction of its superior with its iddle third. (4) The superior border of the trochanter major is on a level with the upper third of the cavity of the joint.

Amputation may be performed by the single flap, anterior or internal; the double flap, lateral, or antero-posterior; the oval; and the circular (Fig. 935). These different methods have been almost indefinitely modified. Hemorrhage should be prevented by the application of the elastic tourniquet (Fig. 936), or a compress[1] to the abdominal aorta. The common iliac may be compressed through the rectum by means of a shaft having a curved extremity, which may be hooked over the brim of the pelvis.[2] The shock due to the loss of the blood in the limb may be prevented by first applying the elastic bandage to the limb, and fixing the tube just below the line of incision.[3] The operation should always be performed with antiseptic precautions, and provision for thorough drainage should be made.

The vertical and circular method[4] is performed as follows (Fig. 937): Make an incision along the outer side of the thigh, extending downward from the top of the trochanter for six or more inches; enucleate the head of the femur from the acetabulum; separate the muscles and tissues; now make a circular incision down to the bone at the requisite point; saw the bone; while an assistant seizes and holds firmly the lower end of the upper fragment, complete the disarticulation. If the artery is not compressed sufficiently certainly to prevent hemorrhage, it may be tied in the flap.

Fig. 937.



Furneaux Jordan's method of amputation at the hip-joint.[6]

Double antero-posterior flaps are made thus:[5] Standing on the outside of the limb, insert the point of a long catling about midway between the anterior superior spinous process of the ilium and trochanter major, keeping it rather nearer the former than the latter; then run it across the fore part of the neck of the bone, and push it through the skin on the opposite side, about two or three inches from the anus; next, carry it downwards and forwards, so as to cut a flap from the anterior aspect of the thigh, about four to six inches in length. When the blade is entered, the limb should be held up, and even slightly bent at the joint; the instrument will then pass along more readily than if all the textures were thrown on the stretch; moreover, there is greater certainty of passing it behind the main vessels, and even dividing some of th fibres, if not the whole, of the iliacus internus and psoas muscles. As th knife is carried downwards, the assistant, who stands behind the operator, shoul slip his fingers into the wound and carry them sufficiently far across to enab him to grasp the femoral artery between them and the thumb; this he may from the inside or outside at will, and with the right or left hand, as may most convenient, the same grasp enabling him to raise the flap as soon as i completed. The flap being raised, the point of the knife should then be struck against the head of the bone, so as to divide the anterior part of the capsular ligament and any texture in this situation which may not have been included in the flap. To facilitate this part of the operation, the knee should be forcibly depressed by the assistant who holds it; the head of the bone will thus be caused to start from its socket, and, if the round ligament is not ruptured by the force, a slight touch with the edge of the knife will cause it to give way. At this period, depression being no longer required, the assistant should bring the head of the femur a little forwards, to allow the knife to be slipped over and behind it; it should then be carried downwards and backwards, so as to form a flap somewhat longer than that in front, the last cut completing the separation of the limb.

---

[1] J. Spence.

[2] R. Davy.

[3] E. Mason.

[4] F. Jordan.

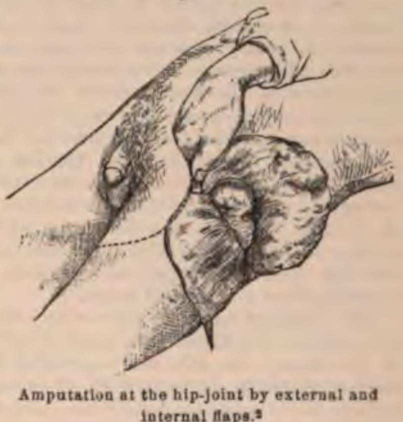
[5] Sir W. Fergusson.

[6] T. Bryant.

The single flap method admits of very rapid performance.[1] The following are the several steps: The patient lying upon the edge of the table, the hip projecting, the artery is compressed upon the horizontal branch of the pubes; the operator then takes a position on the outside of the limb (the left), which is separated from the other and slightly flexed on the pelvis, and raising the soft parts, which cover the anterior face of the limb, enters a very long double-bladed knife midway between the great trochanter and the anterior superior spine of the ilium, directing it at first slightly from below upwards, and from without inwards, so as to reach the head of the femur, and open the capsule of the joint; he now elevates the handle, and carries the knife in a proper direction, the point emerging about an inch below and in front of the tuberosity of the ischium; the knife is then carried downwards along the anterior surface of the bone, and a large semilunar flap is made, extending nearly half the length of the thigh, or six inches; care should be taken that the flap is as long on the inside as on the outside; an assistant raises the flap, at the same time compressing the artery which it contains; the knife is now applied to the capsule, which is divided close to the acetabulum, as if about to cut across the middle of the head of the femur, and at least half of its circumference; the limb is then abducted to luxate the head of the bone, the knife passed behind it, and the soft parts on the posterior portion of the limb divided as in the circular operation.

Lateral flaps (Fig. 238) are made as follows: The patient must be laid upon his back with the tuberosities of the ischia projecting slightly beyond the edge of the bed, and the limb held in a position between abduction and adduction. Then, having determined by anatomical rules laid down the anterior and external side of the articulation, the operator holding perpendicularly a long double-edged knife introduces it at this point with its lower edge looking downwards towards the great trochanter. As the point of the knife enters it should be carried around the head of the femur, on its outer side, whilst its handle is inclined upwards and outwards, and pushed steadily on in this direction so that it perforates the integuments a few lines below the tuberosity of the ischium. While this is being done an assistant grasps the tissues over the trochanter and carries them outwards, in order to

Fig. 938.



Amputation at the hip-joint by external and internal flaps.[2]

---

[1] Malgaigne; Guérin.

[2] T. Bryant.

assist in the formation of the external flap, and the knife is carried downwards and outwards with a slightly sawing motion, around the great trochanter, and along the femur, cutting out a flap from three to four inches in length. The first flap being thus made, the operator grasping the tissues on the inside of the thigh and carrying them inwards, introduces the knife below the head of the femur, and in the inner side of its neck, holding it in a perpendicular position. As it enters, the point of the knife should pass around the neck of the femur and come out at the lower angle of the wound already made, without coming in contact with the bones of the pelvis; it is then carried downwards along the femur, and avoiding the lesser trochanter, so as to make an internal flap of the same length of the external. The flaps being drawn aside by the assistants, and the arteries tied, the surgeon grasps the femur with his left hand, and, holding the knife perpendicularly on the inner side of the head of the bone, cuts the capsular ligament without attempting to penetrate the articulation. The joint being opened, the disarticulation is concluded by cutting the fibrous and muscular tissues which remain.

Care should be taken that the incisions incline moderately forwards down to the curve of the side of the leg, to secure ample covering for the condyles, and that upon the internal aspect it should have additional fulness for the purpose of giving sufficient flap for the internal condyle, which is longer and larger than the external.

Double flaps, long anterior and short posterior, give good results.[1] The surgeon enters the point of the knife between the spine of the ilium and the trochanter major, and carries it across the thigh, as near as may be to the head and neck of the femur, until the point appears on the inside near the scrotum, which should have been previously drawn away. The knife is to cut slowly downwards, to make a flap, under which an assistant inserts his four fingers, in order to be able to grasp the flap and aid in compressing the principal artery, as the operator completes the flap, which should be a large one. The assistant holding up the flap, the surgeon cuts the attachment of the gluteus medius muscle from the upper edge of the trochanter, if it has not been already done, opens the capsular ligament of the joint, and divides the ligamentum teres. The head of the bone can then be readily withdrawn from the acetabulum. The knife, being placed behind the head of the bone and the trochanter, should be carried obliquely downwards and backwards, so as to form a shorter flap behind than was made before.

The oval operation is as follows:[2] Standing on the inside, commence the first incision three or four inches directly below the anterior spinous process of the ilium, carry it across the thigh through the integuments, inwards and backwards, in an oblique direction, at an equal distance from the tuberosity of the ischium to nearly opposite the spot where the incision commenced, carry it upwards with a gentle curve behind the trochanter, until it meets with the commencement of the first; retract the integuments, including the fascia; cut the three gluteal muscles through to the bone; the knife being then placed close to the retracted integuments, cut through everything on the anterior part and inside of the thigh. The femoral or other large artery should then be drawn out by a tenaculum or spring forceps, and tied. The capsular ligament being well opened, and the ligamentum teres divided, pass the knife behind the head of the bone thus dislocated, and cut its way out, care being taken not to have too large a quantity of muscle on the under part, or the integuments will not cover the wound, under which circumstances a sufficient portion of muscular fibre must be cut away.

The circular method has recently been preferred to other methods.[1] The first incision should be made about six inches below the anterior superior spine of the ilium; the skin and superficial fascia being turned back, the second incision should be made through the muscles; these being retracted, the next incision may expose the bone; the joint is now opened, the knife passed behind the head, and the soft parts severed.

[1] C. Heath.

[2] C. J. Guthrie.

XII.

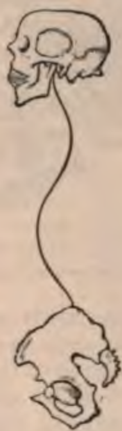
ORTHOPÆDIA.

CHAPTER LXIV.

I. THE SPINAL COLUMN.

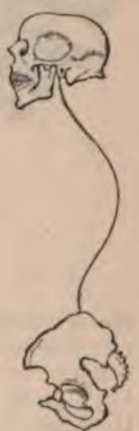
THE spinal column is liable to distortion so as to produce external deformity as follows:[1] Distortion may take place in the antero-posterior direction, either as an exaggeration of the natural curves of the spine, which become so much increased as to produce external deformity, or the natural curvatures of the spine in the antero-posterior direction may be reversed, especially in the dorsal and cervical regions; the dorsal curve may become depressed so as to project anteriorly, and the cervical curve may project backwards instead of forwards, and the lumbar curve frequently becomes straight instead of curving anteriorly; or, distortion may occur as a lateral deviation, which depends upon a peculiar twisted or contorted condition of the spine. Deviations of the spine, either in the antero-posterior or the lateral directions, may coexist with destructive disease affecting the intervertebral cartilages and the bones, or they may be consecutive to such diseases, and remain as permanent distortions after the destructive process has been completely arrested. The latter class of deformities and the diseases which cause them have been considered, and it remains to notice those deviations of the spinal column, due to disturbances of the relations of those forces which maintain the normal curves of the spine.

Fig. 939.



Lordosis.

Fig. 940.



Kyphosis.

Anterior curvature of the spine, lordosis (Fig. 939), may be due to any cause or condition which weakens the ligaments of the spinal column in the region where it occurs as rickets, or so disturbs the relations of the upper part of the spine to the pelvis as to throw the weight of the chest and head backwards in progression, as permanent flexion of the thigh from disease of the hip-joint. The treatment should remove the cause of disability, if possible, as by straightening a flexed thigh. The direct treatment of the curvature should consist in the application of such apparatus as will sustain the weight of the upper part of the body upon the hips, while the spine is lengthened by the suspension apparatus. The treatment is, in general, that of lateral curvature.

---

[1] W. Adams.

Posterior curvature of the spine, kyphosis (Fig. 940), is more often found in the lower cervical and upper dorsal region. It is frequently seen in children and old people, and is due to enfeebled muscles and ligaments, or to habits of assuming positions of stooping, or to both. The treatment is the removal of the causes of the distortion, support of the upper part of the body by apparatus, and efforts to straighten the spine by suspension as in lateral curvature.

Lateral curvature of the spine, scoliosis, when not due to disease of the bones, is accompanied by a rotation of the bodies of the vertebræ upon their own axis (Fig. 941); the direction of the rotation being opposite in different regions, viz: if the lumbar vertebræ are found rotated to the left, the dorsal vertebræ will be rotated to the right. There are usually two or three curves (Fig. 942), but there may be four (Fig. 943). An early diagnosis is important, and may be correctly made by careful attention to the following signs: 1. The scapulæ upon the convexity of the dorsal curve will be raised. 2. The hip upon the concave side of the lumbar curve will be raised. 3. Lines drawn from the umbilicus to each nipple show a marked difference. The spines of the vertebræ are not safe guides, as they do not deviate greatly from their ordinary positions. The affection

Fig. 941.

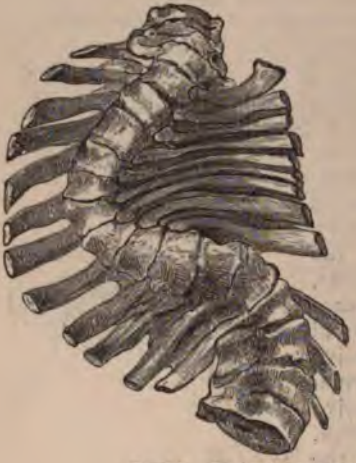


Fig. 942.

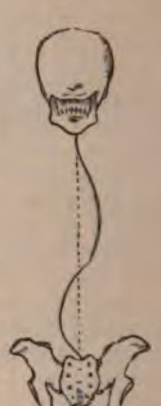


Fig. 943.

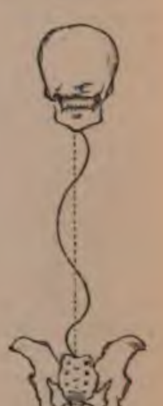
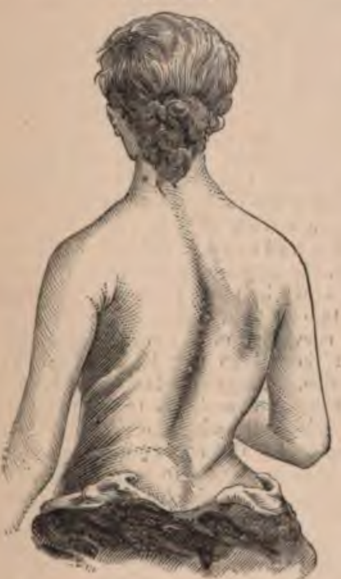


Fig. 941.—Lateral curvature of the spine. Anterior view.
Fig. 942.—Double lateral curvature.
Fig. 943.—Quadruple curve.

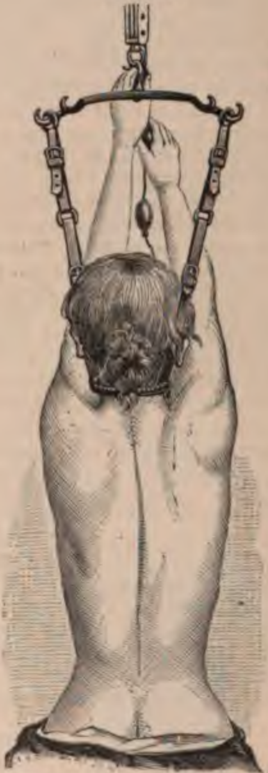
is one of early life, and occurs in both sexes. The treatment[1] of rotary lateral curvature must be governed by the cause which has produced the deformity, and by the condition of the patient when first brought under notice. If the distortion be dependent upon obliquity of the pelvis, caused by inequality in the length of the lower extremities; or owing to a congenital malformation; or to disease of the joints, or fracture, thus causing obliquity of the pelvis; the shortened limb must be artificially increased sufficiently to equalize the length of the two limbs, before any other treatment can be effectual. If the deformity be caused by muscular debility, or want of tone in the general system to keep the body erect, we must by proper training, gymnastic exercises, massage, nutritious diet, and tonics, restore lost vitality and increase muscular power. Careless habits in sitting, walking, or standing must be carefully guarded against, and the vicious tendencies corrected. Partial self-suspension will also be found a most valuable means of correcting the deformity in cases of lateral curvature, if the principle be properly managed. This is effected by the patient having a leather collar passing under the chin and occiput, two straps passing from this up on either side of the head to an iron cross-bar, secured by means of a rope and pulley to a hook or beam in the ceiling. The patient is expected to raise the arms over the head to their fullest extent, and,

Fig. 944.



Curvature before suspension.

Fig. 945.



Curvature removed by suspension.

---

[1] L. A. Sayre.

seizing the rope in the hands, commence to climb up hand over hand until the heels are gradually raised from the floor, barring the discomfort before this point may be reached; the toes, however, should never leave the ground. The effect of this form of suspension upon the curvatures is very marked, as seen in the illustrations of the same person before and during suspension (Figs. 944 and 945).

The hand on the side to which the concavity of the spine faces should always be the one uppermost when the patient has reached the height where the heels are raised from the floor (Fig. 945). While holding herself in this position, the patient should take three full inspirations, then slowly descend until she once more rests firmly on the floor, allowing the arms to fall by the sides and to rest there a few moments; the same course is to be repeated in all three times; for the greater convenience of holding on to the rope, three or four wooden balls should be strung upon it, and secured at a certain point, after the patient has found out the limit of extension. It is necessary, in the performance of this partial self-suspension, that the patient should always keep the arms extended in a perfectly straight line, and simply make each hand go over the other, and no more, so that the muscles of the trunk, rather than the neck, may bear the strain. The apparatus for this purpose may be arranged in one's own room, and may be used for exercise night and morning three times, as before described, until after some weeks, when the number of imposed tasks may be increased according to the hints already given. A very useful exercise is to stand in front of the patient while she is sitting upon a chair or stool, compelling her to turn and twist the trunk in the opposite direction in which the deformity exists, while you resist this movement. Another exercise is that of sitting upon a stool with the arm upon the concave side raised in front on a level with the thorax, while the arm upon the convex side of the deformity is placed behind the back; then seizing a rubber strap in either hand, the ends of which are secured to staples in the wall or door, the patient endeavors by muscular action to unwind, as it were, the rotation of the spine, and thus overcome the deformity. Suspension also may be made from two horizontal bars, as recommended,[1] one being from two to four inches above the other—the hand upon the concave side of the curvature of the spine being the one to grasp the upper bar; exercise upon these bars may be indulged in as often during the day as the patient may desire. Rings attached to ropes of unequal length effect the same object. Yet another exercise is to stand upon a block or box upon the foot of the convex side, and swing the leg upon the concave side, at the same time reaching upward with the arm of the same side, as far as possible, the hand grasping a weight of from two to four pounds, and while in this position to take three full inspirations. This also may be repeated several times daily. Again, making the patient stand erect and bringing the scapulæ together by contraction of the rhomboidei muscles, the arms being placed at the sides of the body, the palms of the hands facing directly forward, and the head held well back, is an excellent posture. A light book kept balanced upon the head, and orders given to march from five to ten minutes, is a good device, for by this means the muscles of the spine are trained to keep the body in an erect position when standing. Massage, manipulation, with the application of electricity to the weakened muscles of the spine, are also valuable adjuvants to restore their tone and vigor.

A great variety of supporting apparatus has been devised for the relief of lateral curvature, but for convenience and efficiency, the plaster-of-Paris jacket excels when judiciously employed. The principles governing its application have already been given (pages 173, 174), but certain features in its employment for lateral curvature should be noted.[2]

---

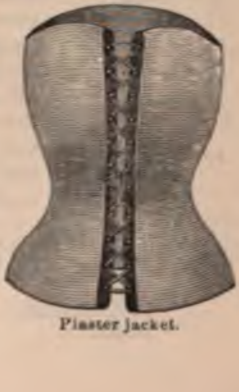
[1] W. Adams.

[2] L. A. Sayre.

In lateral curvature of the spine, the arm-slings are dispensed with, unless the patient be so weak as to interfere with the self-suspension; having put on a tight skin-fitting knitted shirt of double the length required for the jacket, and having placed on the mammæ suitable pads according to the size of the glands, fasten the leather collar around the neck, and then, after pulling on the rope just sufficient to make it tense, direct the patient to extend her arms above the head and reach up on the cord as high as she can while standing flat upon the feet; then slip up the wooden balls which are on the cord and tie a knot at that point at which the tips of her fingers touched; you now direct her to grasp the balls firmly with one hand and climb up hand over hand, the little finger of the upper hand resting upon the hand below; this she is to do until the heels are just raised from the floor, thereby evenly dividing the weight of the trunk between the neck and arms (Fig. 145); be careful that the patient does not bend the arms at the elbows, otherwise the weight of the trunk will be brought to bear upon the muscles of the neck; no injury can occur if the arms are kept straight. Having raised herself to the required height, see that the hand upon the concave side of the spine is the uppermost one upon the rope. With your assistant in front apply the jacket; it is well in those places where the patient is liable to exert the most pressure—as for instance on the concave side—to strengthen it a little by a few extra turns of the bandage half way around. In a few moments the plaster will harden sufficiently to allow the removal of the jacket while she is still self-suspended, this being effected by a section made from the centre of the sterno-clavicular notch to the symphysis pubis.

In cases of persons who are very corpulent, after the removal of the jacket, cut out a small strip in the front of the jacket on either side at the waist, so that the lacings can be drawn even more snugly than the original bandage when the corset is complete; then bring the cut edges together and bind a common roller bandage around it to prevent it from losing its shape while drying, widening the jacket above and below in order to make the edges meet, should they have overlapped when the centre was drawn together; carefully pass the hand over the inside of the corset to see if there are any ridges, which are sometimes caused by the patient allowing the hands to slip and the body settling down. These, however, can be removed while the jacket is still soft, by pressing firmly along them with your thumb or fingers; the jacket is then put aside until the next day. The patient having put on a close-fitting shirt, to be worn under the corset, is then self-suspended, and the jacket sprung open, placed around the body, and bound closely together with a common roller bandage. She is then removed from the suspension apparatus, and the corset is cut out under the arms so as to have no pressure in the axillæ, and in front of the thighs sufficient to allow of free flexion of the lower extremity without chafing. Place the jacket near the fire to dry slowly, and, when perfectly hard, send it to some instrument-maker or saddler to have the strips of leather with lacing-hooks attached. The knitted shirt being twice the length of the body is now reversed over the outside of the jacket and sewed along the top, covering in all the plaster and giving it a neat appearance.

Fig. 946.

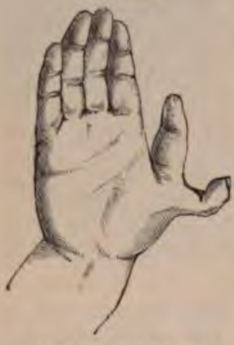


Plaster Jacket.

Leather strips, with lacing-hooks, such as are used on shoes, are sewed down the front of the jacket, the edges in front being previously bound with kid (Fig. 946).

II. DEFORMITIES OF THE HAND.

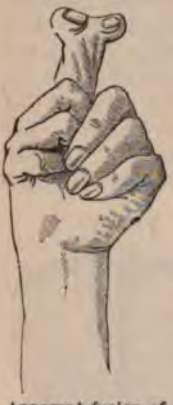
Fig. 947.



Supernumerary thumb.

A supernumerary digit[1] (Fig. 947) appears in many forms, and should be treated according to the peculiarities. (1) If it is attached loosely or by a narrow pedicle, divide the pedicle close to its point of attachment to the skin so that no remains may be left; hemorrhage must be carefully suppressed. (2) If it is more developed, and articulates with the sides of a metacarpal or phalangeal bone, which is common to it and another digit, operate early, and so arrange the incisions as to leave as small a cicatrix as possible. (3) In cases where the additional digit is connected to the head of a phalangeal or metacarpal bone, the removal is likely to involve the opening of the joint of the adjacent phalanx; removal is advisable only in case the additional phalanx impairs the function of the other. (4) If the digit is fully developed, having its own phalangeal and metacarpal bone, removal is rarely advisable, but if required, they must be taken away so as to leave as little deformity and impairment as possible. (5) There may be fusion of digits, or even of hands (Fig. 948), in which no operation is desirable.

Fig. 948.



Apparent fusion of the hands.[3]

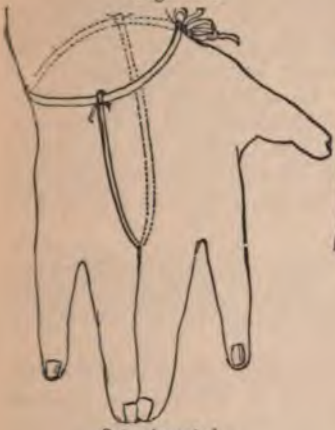
The union of digits, webbed, may be congenital, when it is generally symmetrical; or the result of injuries and burns. The uniting medium may be the skin only, or the skin and deeper tissues, and even the bone. The two apposing digits may be united throughout their entire length, or only in part. Webbed toes do not require treatment. When the union is partial, and does not involve the interspace at the cleft, divide the connecting tissue, and maintain the fingers apart, until cicatrization is complete. When the union at the cleft is complete there is great difficulty in preventing reunion after division. Introduce a seton at the base of the cleft[2] (Fig. 949) and allow it to remain until the opening becomes permanent, when the remainder of the web may be divided; India-rubber tubing introduced at the same point and tied to a band around the wrist makes a good seton.

If the septum is very dense, operate as follows:[4] Make two flaps of the web, anterior and posterior,[5] but reversed (Figs. 950, 951); for the posterior, make

---

[1] T. Annandale.
[2] J. Lister.
[3] J. E. Erichsen.
[4] Diclot.
[5] R. Volkmann.

Fig. 949.



Seton inserted.

Fig. 950.

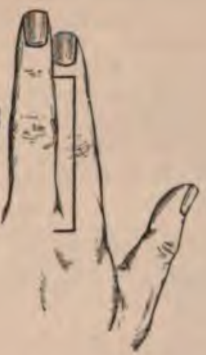


Fig. 951.

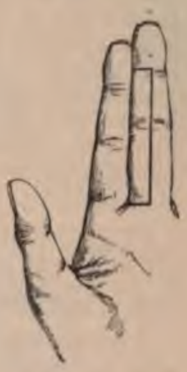
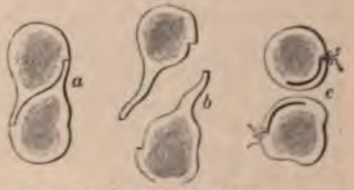


Diagram of flaps in operation for webbed finger, with thick septum.

an incision along the dorsal aspect of one finger the length of the web, and transverse incisions at either extremity to the middle of the dorsum of the other finger; repeat the operation on the palmar surface, but make the longitudinal incision along the palmar surface of the finger which forms the base of the posterior flap; dissect the two flaps and turn them back; separate the fingers which now have each a flap, one attached upon the dorsal and the other upon the palmar surface (Fig. 952); apply the flaps to their respective fingers; the union of these flaps effectually separates the fingers. Or, separate the web along one finger, unite its margins, and thus form a flap for the opposed digit; close the wound left upon the other finger by a piece of skin transplanted from the hip, the hand being bound to the part until adhesion has taken place.[1]

Fig. 952.



Operation for webbed finger. *a*. The lines of the two incisions uniting, so as to divide the web and leave a flap on each side. *b*. The flaps detached from the opposite fingers to those to which they are adherent. *c*. The flaps applied to the fingers and covering in the raw and exposed surfaces.[2]

Flexion of the phalangeal joints, so as to permanently distort the fingers, may be congenital or acquired. When the deformity can be overcome by division of contracted tendons or fascia, this operation must be performed and suitable splints applied. If, however, the conditions are unfavorable to tenotomy, the affected joint should be exsected.[3] In extreme cases amputation is the only successful remedy.

III. DISTORTIONS OF THE FEET.

Distortions of the feet may be due to spasmodic action of one class of muscles, the antagonizing muscles acting normally, or to paralysis of one class, the opposing muscles being healthy. Careful examination of each case will determine whether spasm or paralysis is the cause; but, in general, congenital cases are caused by spasm, and non-congenital by paralysis. The general rule of treatment is to endeavor to overcome those deformities, by appliances, which readily yield to manipulation, and are caused by paralysis, and to divide contracted tendons in those which do not yield readily, and are caused by spasm. The objects of treatment are the restoration of form and function, and the means to be employed are physiological, mechanical, and operative.

---

[1] C. F. Maunder. [2] J. E. Erichsen. [3] W. Adams.

The scientific treatment of severe deformities can only be accomplished by a judicious combination of these three methods, and many of the failures are due to the want of this combination of principles too frequently considered antagonistic to each other.[1]

Selecting talipes varus, the most frequent example of club-foot, the rules of treatment as regards the adoption of the several methods are as follows:[1] (1) If no obstacle exists to the perfect restoration of form by gentle application of force, the defect may be remedied by the manipulations of the nurse, aided, in more marked cases, if necessary, by simple mechanical appliances, as rubber plaster, a boot with springs. (2) If the foot can be nearly but not quite restored to its natural form by the hand, the heel remaining somewhat elevated so as to limit or prevent flexion at the ankle-joint, tenotomy is justifiable, as it greatly hastens the cure. (3) In more severe grades, tenotomy is indispensably necessary; these cases are recognized by the following features, namely, the foot cannot be fully everted or brought to a straight line with the leg by manipulation, and in the attempt to effect this the inner malleolus does not become prominent; (4) the os calcis either cannot be depressed at all, or only to a slight degree, so that after the partial eversion of the foot little or no flexion at the ankle-joint can be obtained.[1]

The following summary of principles of treatment of congenital club-foot deserves attention:[2] 1. Whether the case promises favorably for mechanical treatment only, or needs, as the majority of cases do need, operative interference, commence the treatment as soon after birth as practicable. 2. Reduce the distortion from the state of a compound one (varus) to the simpler form (equinus), by first curing the inversion of the foot, and the tendency to involution of the sole. 3. Avoid the slightest undue pressure upon prominent points of the leg and foot, by careful padding of the hollow parts, and by using only gentle pressure with any bandage; avoid obstruction of the returning blood from the limb. 4. Remove splint and bandage daily, practise gentle movements of the foot in the desired direction, endeavor to prevent the part remaining for an instant unsupported and liable to fall back into the deformed position, until it is found that the foot, on removal of the bandage, retains a perfectly good position and flexibility. 5. Never permit the child to be placed on the feet, or to walk until the form and movements are complete, whatever may be the age of the patient. The only apparatus necessary to carry out this treatment is a splint of tin or pasteboard so adapted to the external parts as to leave a space between the foot and splint when bandages are applied, or rubber plaster applied to the anterior part of the foot, and passing up the external surface of the leg to which it is fastened.

---

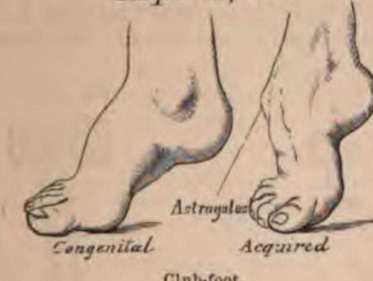
[1] W. Adams.

[2] W. J. Little.

Talipes equinus (Fig. 953) is usually congenital. The treatment is operative and mechanical. The tendo Achillis and plantaris may alone require division, or, in addition, the plantar fascia must be cut, as when the arch of the foot is strongly contracted; the foot should usually be brought into position at once and retained by splints or the gypsum bandage. At the end of a week the shoe should be applied (Fig. 954).

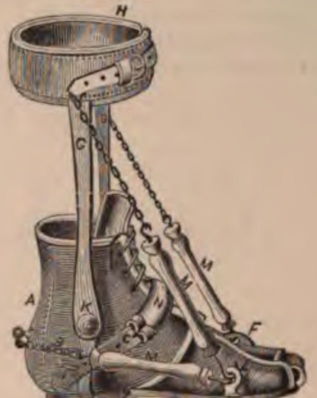
Fig. 953.

Talipes Equinus.



Club-foot.

Fig. 954.

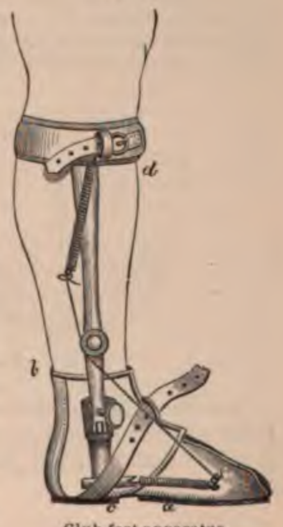


Club-foot shoe.

Its construction and modes of action are as follows: A cushioned iron cap to receive the heel, the leather covering of which is carried over the instep and ankle, and fastened by lacing; elastic tubing, *N*, to go in front of the ankle-joint, further to secure the heel in position, and fastening at *C* an iron hook on outside of heel cap; sole of shoe, *D*, cushioned, and laced securely in front of the medio-tarsal articulation; ball and socket joint, *E*, connecting sole with heel; elevated plate of iron, *F*, properly cushioned, to make pressure against base of first metatarsal bone; steel bars, *G*, connecting the shoe with strap, *H*, to go round the calf; joint, *K*, opposite the ankle; stationary hooks, *L*, opposite the toes, for attaching the India-rubber muscles, *M*, *M*, *M*. These India-rubber tubes have chains attached, and are for the purpose of making flexion and eversion.

Or, the following more simple apparatus may be used: The sole of the strong leather shoe is of metal, with the joint near the heel, allowing lateral motion; a durable spiral spring, *a* (Fig. 955), draws the foot outward by a constant, elastic, and easy traction; this pressure is increased or decreased at will, by fastening the spring in a series of sockets, *c*. The single outside upright steel bar, with joints at the ankle, is fastened round the limb below the knee-joint, and so constructed that the screw at the ankle-joint forces the foot flat

Fig. 955.

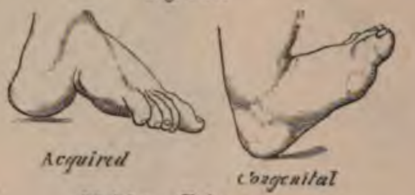


Club-foot apparatus.

upon the floor, the foot in almost all cases being turned under as indicated (Fig. 955); the spiral spring, *d*, attached to a catgut cord and fastened near the toes upon the outside of the foot, elevates the toes and stretches the tendo Achillis, thus drawing the foot to its natural position.

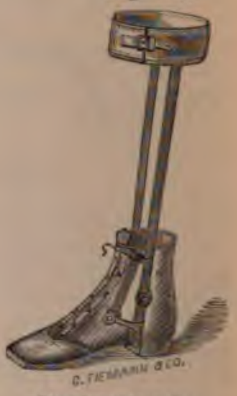
Talipes calcaneus[1] (Fig. 956) is both a congenital and non-congenital affection. In congenital cases the deformity is of the simplest kind, the position of the foot being an exaggerated degree of flexion. In ordinary cases the treatment required is passive exercise and the use of a soft-padded splint applied in front of the leg and foot. In severe cases, with much contraction of the anterior muscles, the tendons of the tibialis anticus, extensor proprius pollicis, extensor longus digitorum, and peroneus tertius should be divided.

Fig. 956.



Talipes Calcaneus

Fig. 957.

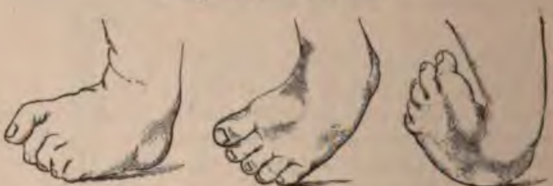


Shoe for calcaneus.

The apparatus has a steel spiral spring, placed on a pivot and playing between brackets of the leg and ankle stem, to depress the front part of the foot by extension; there is not so much danger of falling with this apparatus, when descending stairs. Or, instead of the spring, there may be an elastic band attached to the heel of the shoe below, and to the ring above, which constantly tends to elevate the heel.

Fig. 958.

Congenital Varus.



Club-foot. Three grades of severity.

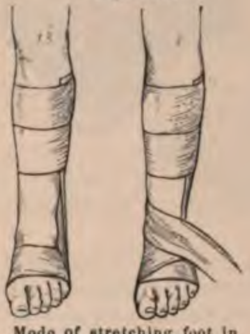
Non-congenital calcaneus is usually the result of infantile paralysis, and, as a consequence, tenotomy is seldom required; palliative treatment alone must be attempted by the application of a proper shoe.

---

[1] W. Adams.

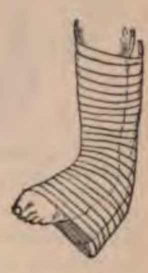
Talipes varus,[1] in its severe form, has the following external characters (Fig. 958), namely, the anterior portion of the foot is turned inwards, forming a right angle, the sole looks directly backwards and the dorsum forwards; the inner border looks directly upwards, and the outer directly downwards. The first stage of treatment consists in correcting the varus by turning the foot outward into a straight position, or by bringing the sole squarely downwards; the second stage consists in overcoming the elevation of the heel, equinus, if that exist. If the foot can be brought around nearly straight with comparative ease, the effort should be made by manipulation and bandaging to correct the deformity. This may be effected by many methods: (1) Apply a strip of adhesive plaster around the anterior part of the foot, commencing on the dorsum and passing around the inside, then across the sole to the outside, and then, while the foot is turned strongly outward, up the outside of the leg to the knee; over this dressing apply a roller bandage; repeat the dressing every second day (Fig. 959). (2) Apply a splint adapted to the outside of the limb, with a foot-piece at an angle with the foot, and, beginning at the upper part, bandage the leg and foot to the splint (Fig. 961); change the dressing every second day, giving to the foot strong traction externally.[2] (3) Give the patient chloroform, and, after forcing the foot outwards fifteen minutes, apply a gypsum bandage; repeat the dressing weekly.[3] In cases which require tenotomy, divide the tibialis anticus and posticus, and if necessary, also the tendo Achillis and flexor longus digitorum; after the healing of the wounds apply the club-foot shoe.

Fig. 959.



Mode of stretching foot in talipes varus, by strapping.

Fig. 960.



Varus treated by bandage.

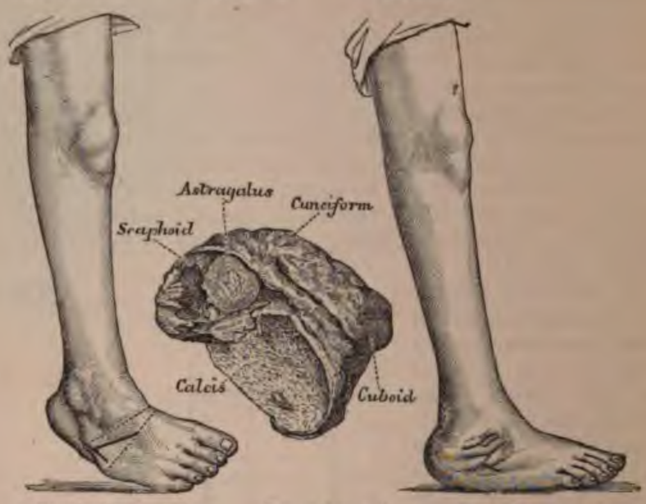
The removal of a triangular mass from the tarsus[4] on the outside has been successfully practised in severe cases;[5] the steps of the operation and the results will be understood by the illustrations (Figs. 961, 962, 963).

Talipes valgus (Fig. 964) is rarely congenital. Marked cases, without rigid muscular contraction, may be cured mechanically in a few months without tenotomy; but severe cases demand a combination of operative, mechanical, and physiological means. The tendons requiring division in the slighter cases are the peronei and extensor longus, and the tendo Achillis, if involved; in very severe cases, the tibialis anticus and the extensor pollicis must also be divided. The mechanical treatment of slight cases in which the tendo Achillis is not divided is as follows: A convex pad of vulcanized India-rubber is

---

[1] W. Adams.
[2] W. J. Little.
[3] A. Ogston.
[4] D. Colley.
[5] T. Bryant.

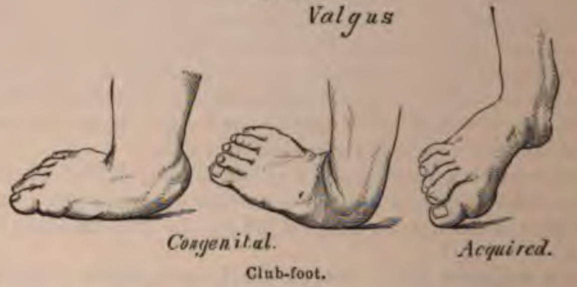
Fig. 961. Fig. 962. Fig. 963.



Foot before operation. Bones removed. Foot after operation.

placed inside of the boot in the normal situation of the arch of the foot which it is intended to support; it should extend half way across the sole of the foot, and rise on the inner side so as to support the navicular bone; the heel should be raised on the inner side about a quarter of an inch so as to twist the foot inwards and throw the weight on the outer side. In more severe cases it is necessary to add a steel support, attached to the outer side of the boot and carried up to the calf of the leg, where it is connected with a semicircular steel plate, and a strap which encircles the leg; a free joint should correspond with the ankle, and a leather strap attached to the inner side of the boot should pass across the ankle-joint and buckle outside the steel support. In the most severe cases, after tenotomy is performed, a shoe must be applied which effectually brings the foot by degrees into position.

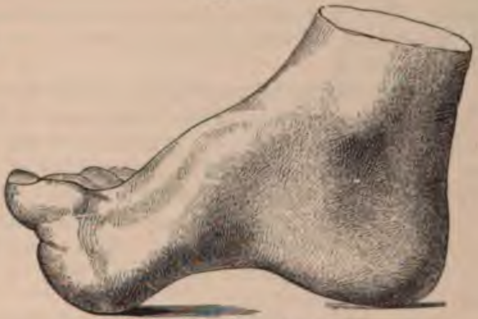
Fig. 964.



Club-foot.

Hollow club-foot,[1] pes cavus (Fig. 965), is due to paralysis of the interossei muscles, the short flexor, and adductor of the great toe; the first phalanges are extended upon the metatarsal bones, and the last two phalanges flexed upon the first.

Fig. 965.

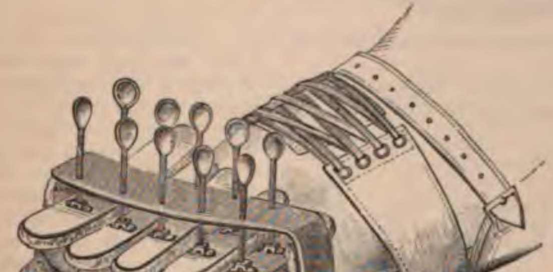


Hollow claw-foot, *pes cavus.*

When the interosseous muscles are paralyzed or atrophied, the tonic contraction of the muscles which extend the first phalanges and that of the muscles which flex the last phalanges being no longer opposed, the claw-like condition of the toes gradually becomes augmented; the posterior extremities of the first phalanges are subluxated upon the heads of the metatarsal bones; then the curve of the plantar arch becomes increased and the plantar arch shortened; then certain articulations and their ligaments become deformed as in all club-feet.

From the position of the toes and from the increased arch of the foot the whole pressure in walking is borne upon the heel and upon the skin covering the unnaturally prominent heads of the metatarsal bones, which latter become tender in consequence, especially that over the great-toe. The treatment consists in, 1, stimulation of paralyzed muscles by faradization; 2, the division of the tendons of those muscles which by their tonic contraction maintain and increase the deformity. The muscles more often divided are the extensor of the great-toe, the tendo Achillis, and in addition a very tight band of

Fig. 966.



Apparatus for obtaining extension of the toes without division of tendons.[1]

---

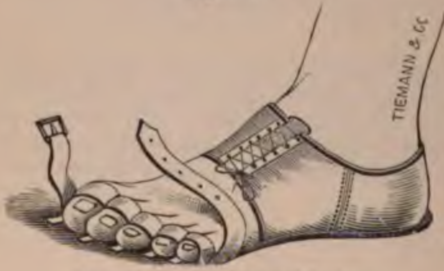
[1] J. E. Erichsen.

the inner division of the plantar fascia. The Scarpa shoe is used after the operation having hinges across the middle and rack-and-pinion movement, so that the depressed heads of the metatarsal bones may be raised by the anterior half of the sole. In slighter cases an instrument (Fig. 966) may be used to obtain the extended position of the toes without division of the tendons; or, the apparatus (Fig. 967) may be used.

Contraction of one toe,[1] usually the second on each side, occurs in which the proximal phalanx is either on its normal level or slightly drawn up, and the two distal are bent down at an acute angle, the apex of which is formed by the articulation of the first with the second. It appears to be due to the contraction of the digital prolongation of the plantar fascia, and is frequently a source of great inconvenience and even permanent lameness. The remedy is subcutaneous division of this fascia opposite the lower part of the second phalanx, and straightening the toe.

Distortion of the toes occurs from pressure of the shoe. The formation of a bunion over the first metatarso-phalangeal articulation, its subsequent inflammation, and destruction of the joint, cause a permanent displacement of the toe which affects the relations of the other toes. This condition is best remedied by excision of the diseased joint, and immediate restoration of the toe to its straight position.

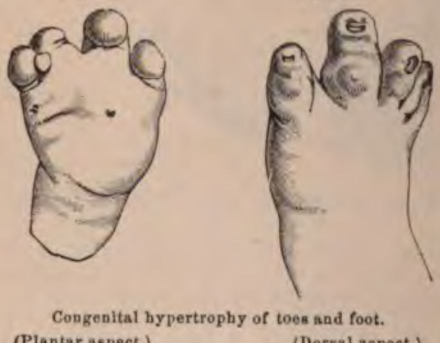
Fig. 967.



Apparatus for overriding of the toes.

The apparatus for overriding consists of a steel sole arranged with slits corresponding to the spaces between the toes. A strap of webbing is passed through these slits and over the contracted toe (or over each and all, as the case may require), and buckled or tied under the sole, tense enough to straighten the toe. This apparatus is kept in place by a thin silk, linen, or cotton covering, laced to the instep, and may be worn in an ordinary shoe (Fig. 967).

Fig. 968. Fig. 969.



Congenital hypertrophy of toes and foot.
(Plantar aspect.) (Dorsal aspect.)

Congenital hypertrophy of toes and foot (Figs. 968, 969) is occasionally met with. The only remedy is the adaptation of suitable apparatus to meet the deficiency of the foot.

---

[1] J. E. Erichsen.

IV. MALPOSITION AFTER FRACTURE.

When union takes place with such distortion as to impair the usefulness of the limb, the deformity must be rectified.

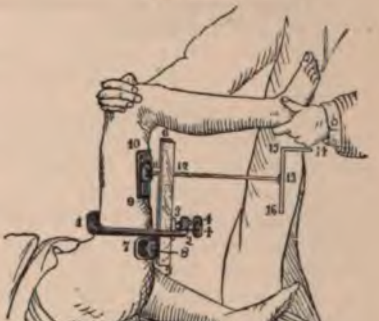
Extension and compression may be made in recent cases; immediate straightening may follow, with the right hand grasping and extending the extremity, while, with the other, firm compression is made upon the convex portion; to obtain more gradual results apply a weight and pulley to the extremity and bind a straight splint on the concave side with as much tightness as the patient will bear.

Refracture must be effected if the first methods fail. Proceed as follows: The patient being under an anæsthetic, bend the limb over the knee,[1] or over the edge of a table or board; or, the limb being well fixed by assistants, the weight of the body, or even of two persons, may be thrown upon it.[2] When the fracture occurs, a rotary motion should be given to the lower fragment.[2] If these means fail, resort may be had to the osteoclast, or to osteotomy. The osteoclast has frequently been used,[3] but there has been a lack of precision as to the point of fracture This defect has been overcome and a transverse fracture may be produced at any selected point with ease, certainty, and freedom from after-complication.

The osteoclast, as perfected,[4] consists of a U-shaped bar of iron (Fig. 970, 1, 2) three-fourths of an inch square, on one ramus of which is placed a hard rubber pad one and three-fourths inches wide, and curved to fit the rounded surface of the thigh.

On the side opposite to this pad a V-shaped bar of iron (3) is fitted under the ramus, and controlled by two thumb-screws (4, 4) which pass through the ramus itself (Fig. 970). A strong piece of hard wood (5, 6) is used for the fracturing lever. At the lower end of the lever a pad (6), similar to the one just described, is firmly fastened and is intended to rest over the trochanter major. The pad resting over the trochanter major, the body of the lever passes under the V-shaped piece, extends along the femur and parallel to it, and has fitted into it, at the distal extremity, female portions of a screw, through which a threaded rod (12) works as its point rests in a socket, upon the outer side of a free pad (9, 10), also rubber-lined, that is placed in contact with the distal extremity of the femur. The threaded rod terminates in a crank-like handle (13, 14, 15, 16). The instrument is placed so as to avoid, as much as possible, injurious pressure on the large vessels and the larger masses of muscle. The regulating screws (4, 4) are then adjusted until the three pads mentioned sustain a uniform and firm pressure, when by a few rapid turns of the crank the fracture is produced beneath the pad.

Fig. 970.



Osteoclast.

Osteotomy, section of bone, though creating all the conditions of a compound fracture, has proved an entirely safe and successful procedure when antiseptic precautions are used. The operation may be performed with a saw, or a chisel and mallet. The saw[1] is three-eighths of an inch in width, with one inch and a half cutting edge at the end of a small shank three inches in length. Make the puncture down to the bone with a long tenotomy knife; divide the muscles, and open the capsule freely; on withdrawing the knife, pass the saw along the track made, down to the bone, and saw through it; straighten the limb and close the wound firmly with suture, or adhesive plaster; apply a splint or a gypsum dressing. When the chisel is used, select a carver's cold chisel, three-eighths of an inch in width at the cutting edge, which is widest, and three inches and a half long in the shaft; make an incision by penetration with a pointed knife, double-edged, down to and in the long axis of the bone, dividing the periosteum; introduce the chisel by the side of the knife, and place it at right angles to the shaft of the bone; with a light wooden mallet drive the chisel well into the bone, then partially withdraw, and again drive it onwards, inclined somewhat obliquely forwards, and then backwards, so as to divide the bone in the rest of its thickness; finally, gradually and carefully extend the limb, breaking any small portion which may have escaped the chisel. The incision of the skin should be a little to one side of the point where the bone is divided to render the deep wound subcutaneous. The wound should be closed with a catgut drain, iodoform dressings applied, and a splint, or, better, a gypsum dressing, used to render the limb immovable.

---

[1] S. D. Gross. [2] F. C. Skey. [3] Rozzoli. [4] C. F. Taylor.

When there is such a degree of shortening of one leg by injury or disease as to interfere seriously with locomotion, the femur or tibia and fibula of the opposite limb may be fractured by the osteoclast, or divided with a chisel and reset so as to make it of equal length with the shortened extremity. Osteotomy is the better operation, as the bone can be divided obliquely, and this admits of easy gliding of the fragments.[2]

V. CURVATURES AT THE KNEE.

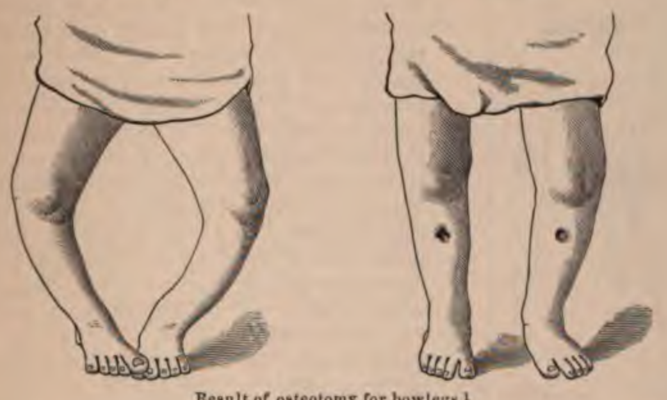
The knee-joints occasionally become so weak through relaxation of the ligaments as to require compensative appliances to enable the patient to walk with freedom. The relaxations are due to slight anomalies of formation, or too feeble development of those parts, and the results are manifested especially at the time when the growth is most vigorous, and the ends of the bones assume the final form.[3] Rickets is the most frequent cause of bending of the bones of the leg, and relaxation of the ligaments of the knee-joint. The curvatures are of two kinds.

Bowlegs, genu varum, depends upon relaxation of the external lateral ligament of the knee and shrinkage of the internal lateral ligament, except when it is due to bending inwards of the femur.[3] In the early period, the knee should be supported by apparatus which maintains the straight position of the limb. When the deformity is permanent (Fig. 971), the deformity must be overcome by dividing the bones most curved and straightening. Usually the tibiæ are curved in the upper third, and if divided and the bone

---

[1] W. Adams. [2] R. F. Weir. [3] T. Billroth.

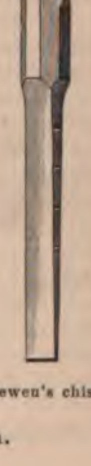
Fig. 971. Fig. 972.



Result of osteotomy for bowlegs.[1]

straightened the deformity will be overcome (Fig. 972). The operation is very simple. Prepare the limb by washing and shaving, and irrigate the wound during the operation with the bichloride solution. Select an osteotomy chisel (Fig. 973) and mallet; make a longitudinal incision down to the bone with the scalpel; now apply the cutting edge of the chisel transversely, and, with repeated blows of the mallet, nearly divide the bone; then fracture the remaining portion; apply a catgut drain and close the wound with the continuous suture; straighten the limb, apply iodoform gauze, and finish the dressing with the plaster of Paris dressing, extending from the foot to the hip.

Fig. 973.



Macewen's chisel.

Knock-knee, genu valgum, results generally from relaxation of the internal lateral ligament, and shrinkage of the external ligament, with secondary contractions of the biceps femoris.[2] In some cases, especially those induced by rickets, there is not only lengthening of the internal and shrinkage of the external lateral ligaments, but there is overgrowth of the internal condyle to such extent as to prevent straightening the limb.

In the early stages the weight of the body should be taken from the knee, either by confinement with a side splint to which the knee is firmly bandaged, or by allowing exercise with the common hip splint properly applied. In later stages apparatus is useful which straightens the limb, and supports it by means of a steel brace applied upon the concave side, with bands around the leg and thigh, and a cap for the knee. If both knees are affected, an apparatus must be applied to both limbs from the hips to the feet, not unlike that required in paralysis of both limbs.

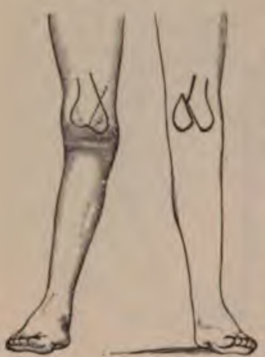
---

[1] J. Ashhurst, Jr.

[2] T. Billroth.

If the deformity is due to curvature of the femur or tibia, these bones should be straightened by refracture with the chisel and mallet, and united in the straight position. In those cases in which the internal condyle has become lengthened, which is more frequently the case, and which will be apparent on inspection and manipulation, the deformity can be overcome only by operative procedures. There are several methods[1] of correcting this deformity, but the following are the most useful procedures: Section of the internal condyle may be made (Fig. 974) with a view to its replacement and reunion on a higher level (Fig. 975). The condyle may be separated with a saw[2] or with a chisel.[3] Section with a saw is much the more difficult operation, but with antiseptic precautions it has proved very successful. The operation is as follows:—

Fig. 974.



Drawing illustrating Dr. Ogston's operation. *Right* limb shows line of section of the inner condyle of the femur. *Left*, inner condyle brought to required position [4]

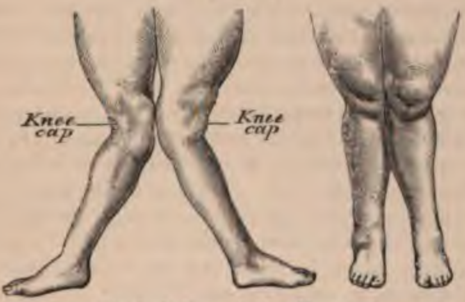
Flex the knee as far as possible, and turn the thigh outwards; introduce a long and strong tenotome knife, three and a half inches above the tip of the internal condyle on the inner side of the thigh, and so far back as to be opposite the ridge of bone running between the linea aspera and the condyle; carry the blade forwards, downwards, and outwards over the front of the femur, with its cutting edge directed to the bone; when its point is felt under the skin, in the groove between the condyles where the patella would normally have been lying in the flexed position, divide the soft parts and periosteum by withdrawing the knife; through the cut thus made introduce a narrow saw, and divide the condyle nearly to the popliteal space; now forcibly straighten the knee, and the remaining attachments of the condyle will be readily fractured.

Section with the chisel is free from the objections which apply to those methods involving a more or less free opening of the knee-joint:[3] Introduce an antiseptic scalpel above the most prominent part of the internal tuberosity, and divide the soft parts and periosteum; insert by the side of the knife an antiseptic chisel, and with a few strokes of the mallet penetrate the condyle to its greatest depth, but only as far as the cartilage covering it; the direction of the chisel should be first towards the intercondyloid groove, then partially withdrawn, and its direction altered forwards and backwards, until the condyle is loosened, but not separated. Straighten the limb, breaking off the divided condyle, and pushing it upwards with the head of the tibia; close the incision, and apply a long straight splint to the outside of the leg, with a bracket at the knee; at the end of two weeks apply an immovable apparatus, as gypsum, and retain it for three or four weeks in children, and six to eight in adults, when passive motion must be begun and persevered in until the functions of the joint are completely restored.

[1] T. Annandale; J. Lister. [2] A. Ogston. [3] H. A. Reeves. [4] T. Bryant.

2. Section of the femur may be linear or cuneiform, supra-condyloid, or through the centre of the shaft. Linear section, supra-condyloid, is to be preferred in ordinary cases. An elastic bandage may be used, but is not necessary. Flex the leg on the thigh, rotate the thigh outward, and lay it upon a sand pillow moulded to the limb. Make an incision down to the bone, along the ridge running from the tubercle for the attachment of the adductor magnus to the linea aspera; pass the chisel down to the bone along the knife, and turn it so that its edge is at right angles to the long axis of the shaft; as the chisel penetrates incline it outward and forward away from the vessels; when it has passed nearly through to the external wall, seize the two portions and fracture the remainder of the shaft. The wound should be well irrigated with bichloride solution, and then closed with the continuous suture. Apply iodoform dressings, and while the limb is held in a straight position, apply a plaster-of-Paris bandage. On removing these dressings at the end of two or three weeks, if the deformity is not overcome, the tibia may be divided in a similar manner, the limb made straight, and the same dressings applied. The results of this operation are uniformly satisfactory (Fig. 975).

Fig. 975.



Appearance of limbs before and after Macewen's operation.[1]

Anterior curvature of the bones of the leg is a deformity which sometimes occurs as a result of rickets in a child who has been allowed to walk during the stage of softening of the bones. It is now easily and safely corrected by osteotomy. Both bones should be divided. If the curvature is very angular, it is better to remove a wedge-shaped piece from the angle.

---

[1] T. Bryant.

CHAPTER LXV.

ANCHYLOSIS.

ANCHYLOSIS,[1] stiffness of a joint, is due to pathological changes in and around an articulation, as follows: 1. Cicatricial adhesions between adjacent surfaces of a joint. 2. Cicatricial shrinkages of the articular capsule, of the accessory ligaments, and even of the semilunar cartilages. 3. Adhesions of the walls of the synovial sacs. 4. Bony deposits in the joint on the articular surfaces of the bones implicated. 5. Loss of substance from caries, so that the epiphyses stand obliquely to each other, and cannot be brought into position. These changes are usually the result of disease, but a healthy joint will finally become anchylosed if kept immovable for years, for the secretion of synovia is arrested, the synovial membrane becomes dry and tough, the cartilages become filamentary, and the entire apparatus finally changes to a cicatricial connective tissue which may ossify. When the rigidity is due to bony formations, it is true anchylosis, and when caused by fibrous structures it is false anchylosis. Generally, where true anchylosis exists, the sensation on grasping the limb above and below the joint, and on endeavoring to move one part on the other, is unmistakable; this sensation of solidity is never felt when the adhesions are fibrous. As bony anchylosis is the exception, and fibrous adhesions infinitely more common, the full effect of chloroform should always be obtained before anchylosis is pronounced to be bony. Immobility alone is not proof of true anchylosis, for it frequently exists where the adhesions are fibrous; and even where the full effect of chloroform has been obtained, so that all muscular influence has been removed, immobility sometimes remains as great as before. In the treatment of fibrous anchylosis, when the contraction can be entirely overcome under the influence of an anæsthetic, rupture the adhesions and place the limb in a condition of perfect rest, and apply ice-bags to avoid inflammation. If the parts do not yield, remove such impediments to extension as are offered by contracted muscles and by tense fasciæ, by dividing subcutaneously all such structures as are likely to interfere with the extending process.

Cicatrices and adhesions should be previously subcutaneously divided, so that unequal pressure may as far as is possible be removed during the act of extension, and especially from those weakest points in the neighborhood of cicatrices; should the continuity of the integument be endangered by the extension which may be necessary for the replacement of the articular surfaces, it is preferable to complete this replacement on a second occasion rather than to risk the smallest rent of the skin; those cases are attended with the greatest success where the adhesions are ruptured on the application of moderate force and which yield with a single snap, where the skin is in no measure endangered, where the adhesions are extra-capsular, and where the integrity of the joint is so far preserved that there is no tendency to dislocation.[1] When, however, in consequence of partial dislocation, of extensive adhesions within the joint, or from other cause, considerable force has to be employed, be careful as to the direction and extent of the force used, especially when cicatrices exist, that the integument may not, by a violent movement of the limb, be ruptured; with care this accident will never occur; as it is not always possible to destroy all the existing adhesions without endangering the continuity of the integuments, it is more prudent, when great tension has been induced and rupture of the skin appears to be imminent, to remit extension, and to complete the operation on a future occasion.[1] After the subsidence of any inflammation or tenderness which may have been induced, the remaining adhesions will probably yield to gentle pressure, or on the application of slight force.[1] The adhesions having been ruptured, no further motion or examination of the joint should be permitted.[1]

---

[1] T. Billroth.

The phalangeal joints[2] are often distorted by disease, the extensor muscles giving the direction to the displacement more frequently than elsewhere; the extensors may prevail over one phalanx and the flexors over another. In the treatment, section of tendons is rarely required; the bent joint can easily be straightened under an anæsthetic with the greatest ease, and the straight joints resume their natural posture without external aid. The straightened finger should be put up in the straight position, and passive motion must be resorted to and continued until free motion is secured.

If anchylosis is a necessity, the bent position of a finger, so as to touch the thumb, is most useful.[3]

The wrist-joint is rarely anchylosed without more or less implication of the carpal joints; when separately anchylosed its motions are so largely supplemented by the carpal joints that its functions are not impaired to such an extent as to justify other than the most moderate efforts to overcome the stiffness. The patient being under an anæsthetic, attempt flexion and extension, carefully avoiding too great strain of the carpal joints. The after-treatment requires rest, with applications of ice, for two or three days, and then passive motion.

The elbow-joint[2] is frequently anchylosed in a more or less straight position which seriously diminishes the usefulness of the hand. In false anchylosis, give an anæsthetic, and secure rotation of the forearm if possible; next, first move the arm in the direction opposite to that which is especially to be obtained, that is, if the joint is too much flexed, flex the forearm still more; and if too straight, extend it; when the joint is over-flexed, grasp it in such a manner as to keep the thumb over the head of the radius and biceps tendon; during the act of extension, make a number of jerky actions, rather than apply a steady force; if the tendon of the biceps becomes perfectly tense, and the head of the radius does not follow the movement, the effort must be discontinued or the tendon be divided to avoid dislocation of the radius.

In flexing an over-straight arm, greater power is secured by placing the knee in the bend of the elbow, care being taken not to use such pressure as will endanger vessels and nerves. If the triceps resist much, in a person under eighteen, or even more, if development is retarded, the muscle should be divided. The after-treatment requires rest and ice-bags until the danger of inflammation is passed, when passive motion must be perseveringly made.

---

[1] B. Brodhurst. [2] R. Barwell. [3] T. Bryant.

If the anchylosis is true, or bony, exsection may be practised. The steps of the operation are the same as for caries, except that a triangular piece of bone must be removed at the seat of the old articulation. Passive motion must be early practised, to prevent union.

The shoulder-joint[1] is rarely affected with true anchylosis; it is difficult of diagnosis, owing to the mobility of the scapula. Proceed as follows: The patient sitting on the floor, or on a low stool, stand behind and fix the shoulder with the thumb of one hand on the acromion and the fingers in the axilla; now lift the arm away from the side without force, and in a plane parallel with that of the chest; if there is any motion it will be detected. To obtain motion, give an anæsthetic, and place the patient on the opposite side; bend the elbow at right angles, and, using the forearm as a lever, grasp the upper arm as high as possible, and rotate the humerus, but no further outwards than is normal; when this movement is free, place the arm in front of the body, across the chest, till the elbow lies in front of the ensiform cartilage, and rotate the humerus a little; then place the arm behind the trunk until the elbow lies just above the sacro-iliac synchondrosis, but do not rotate; having loosened the adhesions, to a certain degree, again grasp the shoulder as at first, lift the arm as far as it will go without force, and commence circumduction in as large a circle as possible; the arm should be brought to at least a right angle and a half with the body, and even more elevation is desirable; considerable extension should be made during these manœuvres. Require rest in the recumbent position for two or three days, and apply ice-bags; as the tenderness subsides, commence gentle passive motion. If the anchylosis cannot be overcome, the free movements of the scapula eventually give great freedom of motion to the arm.[2]

The knee-joint may be anchylosed at any angle, but that which is most useful is the nearly straight position, which should be secured, if possible, when bony anchylosis is impending. If the angle is greater, the question of an operation should be decided as follows, in fibrous anchylosis: (1) If the limb be in such posture as to permit tolerable locomotion, it is wrong to break down an anchylosis large, old, and inveterate enough to require more than a moderate exertion of force; (2) If the limb be in a position which renders locomotion hardly tolerable, it is justifiable to use a great amount of force to break down the anchylosis and restore the limb to position.[1] The operation of forcibly breaking the fibrous structures about the joint should be performed as follows: The patient being fully anæsthetized, place him in a prone position with his chest and face elevated; bring the knee to the edge of the table, and require an assistant to hold the thigh firmly down; now place the left hand in the popliteal space, so as to depress the thigh, and the right on the posterior part of the leg close above the calf and on the condyles of the tibia; if the anchylosis is recent, and not too firm, the leg will gradually give way with a soft crackling and tearing; should extension not be so readily made, place the hand lower on the leg, about the calf or close below it, and use much less force to avoid fracturing the tibia just below the condyles; if these efforts fail, seize the leg from the front and attempt gradual flexion, as adhesions sometimes rupture more readily by flexion than extension; continue alternate flexion and extension until the limb is brought into proper position, but avoid painful twisting and wrenching.[1] If the patella is attached, it must first be loosened by pressure with the thumbs, or aided by some covered hard lever.

---

[1] R. Barwell.

[2] T. Billroth.

If there is great resistance to the effort of extending divide the crucial ligaments as follows:[2] Select a tenotome with a blade three inches long, one inch of which is for cutting. Place the patient on the back, the affected limb is held steadily in extension so as to render tense the anterior crucial ligament; enter the tenotome to the inner side of the ligamentum patellæ, a quarter of an inch above the articular surface of the tibia, and carry it backwards and outwards so as to pass between the tibial spine and the external condyle of the femur below the ligament (crucial). The flat of the blade is towards the articular surface of the tibia, the back towards the ligamentum patellæ, the edge towards the spine, after entering the joint. The cutting edge of the knife is now to be carried across the joint from side to side, the edge being directed so as to pass over the spine, and divides the anterior crucial ligament just above its attachment to the tibia; the posterior crucial will probably also be divided, but as it lies further from the skin puncture it is well to reverse the edge of the tenotome, without withdrawal, pass it more deeply into the joint, and carry it from the internal to the external condyle, retracing the path already travelled.

One cause of failure in the treatment of fibrous anchylosis is that the surgeon becomes alarmed at the audible fractures that occur and contents himself with slight motion for the present operation, intending to complete the cure by subsequent operations, and thus, by making frequent attempts to increase these slight movements, he sets up a new inflammation in the parts involved, preventing any further interference, and frequently resulting in a more firm consolidation of the joint than before; whereas, by breaking up the adhesions thoroughly and completely at the time of operation, and then, by proper dressings of the parts and the prevention of inflammation, he may confidently expect that he will have a much more satisfactory result.[3]

The immediate dressings which most effectually prevent inflammation are applied as follows:[3] First strap the toes with strips of adhesive plaster if it be a small subject, or if an adult with long toes, pad the toes with cotton and bind with bandage, carrying the roller over the foot strongly and firmly; padding the malleoli and tendo Achillis with cotton the roller is carried snugly over them; two strips of adhesive plaster having been placed on either side of the leg for extension, the roller is passed over them, leaving their lower extremities exposed for the future attachment of weight and pulley, and is carried up as far as the top of the tibia; pad the popliteal space and firmly strap with strips of adhesive plaster, each one shingling over the other until the entire knee is covered; continue the roller over the knee smoothly and very firmly to the junction of the middle and lower third of the femur, when a piece of sponge an inch or two in length, and about the size of the thumb, is placed over the track of the femoral artery, and the roller carried on over this sponge for the purpose of making partial compression of this artery, so as to diminish its calibre and thus prevent the full supply of blood to the parts below; great caution is necessary in the application of this pressure upon the artery not to obstruct the circulation so as to produce gangrene; then secure the limb in an absolutely immovable position either by a wooden splint well padded placed behind the leg, gutta percha, sole leather, plaster of Paris, iron bars on either side of it, or in any way that best prevents the slightest possible movement. Place the patient in bed, the lower extremity of which is raised ten or twelve inches higher than the head in order that the body may act as a counter-extending force, and apply the weight and pulley over the foot of the bed to the strips of adhesive plaster at the ankle-joint; place ice-bags around the knee, and use such constitutional treatment as may be required; at the end of six or seven days remove the dressings, take the sponge from over the femoral artery, cut the adhesive straps from over the knee, carefully examine the parts, and give a very slight movement to the joint for the purpose of preventing solidification; reapply the dressings with the sponge left off from over the femoral artery; still continue the extension and the elevated position of the limb for some days, until all danger of inflammation is passed; at the end of a few days again remove the dressings, and give more free motion to the part.

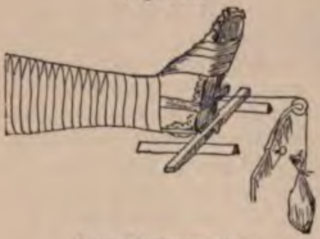
---

[1] T. Billroth. [2] L. McL. Tiffany. [3] L. A. Sayre.

It may be necessary at the time of making this movement, and the three or four subsequent movements, to administer an anæsthetic; these movements should be made quite free when an anæsthetic is used, but not to the point of exciting any new inflammation. After some days the passive movements can be made daily, accompanied with friction, and shampooing should be very liberally done. These movements may be increased in frequency as the case advances, until finally an instrument can be so adjusted to the limb that the patient can cause the movements many times in the day without the attendance of his physician. So soon as the parts can be pressed together by bearing the weight of the body upon the foot without tenderness, the extension can be omitted, and the movements daily increased.

The proper support of the foot is an important indication in making extension. If the foot is not well sustained, so as to be freely movable, the weight has to be much increased, but if the limb moves with no friction, the weight may be comparatively light. To effect this object a simple framework is constructed which allows a cross-piece to slide freely on two horizontal bars (Fig. 976).

Fig. 976.



Extension apparatus.

If the joint has long been bent at a right angle, not only do the structures about the joint contract, but the condyles lengthen so as to render it impossible to bring the tibia down to its proper position, even by dividing the resisting tissues, as the ham-string tendons; in such cases the extremities of the condyles have been cut away successfully with antiseptic precautions.[1] When flexion of the leg and subluxation of the tibia is progressing, the limb may be restored by gradual extension of the joint, and counter-pressure over the upper extremity of the tibia.[1]

---

[1] J. Lister.

The subcutaneous division of the crucial ligaments has been advised.[2] 1. Divide the ham-string muscles, lateral ligaments, and any opposing bands of fascia. 2. When these wounds are healed, extend the limb under anæsthesia, and pass a tenotome having a blade three inches and a cutting edge one inch (the flat of the blade towards the tibia, the back towards the ligamentum patellæ, and the edge towards the spine) on the inner side of the ligamentum patellæ a quarter of an inch above the articular surface of the tibia; carry it backwards and outwards (the cutting edge about two and a half inches in an adult), so as to pass between the tibial spine and the external condyle of the femur below the anterior crucial ligament; now carry the knife from side to side across the joint, the edge being directed so as to pass over the spine and divide the anterior crucial just above its attachment to the tibia, next turn the edge of the tenotome without withdrawal, pass it more deeply into the joint, and carry it from the internal to the external condyle, retracing the path already travelled and dividing thus the posterior crucial. If the operation has been successful, the limb can be well extended; apply a gypsum splint till danger of inflammation has passed, and then resort to passive motion.

If true anchylosis exist and the limb is in such a position as to be useful, no operation should be attempted. When, however, the flexion is extreme, the following procedures are justifiable, namely, amputation below the knee, exsection of the joint, or resection of the shaft of the femur.

(1) If the limb is in a state of atrophy, amputation should be performed an inch below the tubercle of the tibia with bilateral flaps; this stump allows the application of an excellent artificial limb, with direct bearing upon the knee.[3] (2) If the leg is well developed a wedge-shaped piece of bone should be removed from the knee, of such shape and dimensions as to permit the foot to be brought to the ground at a slight angle, and in this position anchylosis should be obtained.[4] The operation is as follows: If the knee is at right angles, preparatory to the operation, divide the tendons of the biceps, semi-tendinosus, semi-membranosus, and gracilis muscles several days before. The tourniquet having been applied to the upper part of the thigh, or elastic bandage, make an incision from the outer to the inner condyle, across the middle of the patella, and a second incision from the middle of this, perpendicularly downwards, to the tuberosity of the tibia; dissect the included angles of integument down to a finger's breadth below and parallel with the margin of the articular surface of the tibia; cut the ligamentum patellæ and the fibro-ligamentous tissues on either side on the same level to the extent of nearly two-thirds of the circumference of the bone. With the amputating saw make a section of the tibia at three-fourths of an inch below the joint anteriorly, directed with a slight obliquity upwards, so as to terminate at the margin of the articular surface posteriorly, *c*, *d* (Fig. 224); commence the second section through the upper part of the patella, parallel with the first, *a*, *b*, and on a plane forming an angle with it, less than a right angle, and continue to about the same extent as in the first section with the same saw; complete the remainder of the section through the tibia, as well as through the condyles, with a metacarpal saw and chisels; remove the included wedge-shaped portion of bone. The after-treatment is the same as for excision of the knee-joint. (3) A section of the femur may be made thus:[5] Remove a triangular portion of the shaft, *e*, *g*, *f* (Fig. 224); there should not be a complete section of the bone at its posterior part, *g*.

The hip-joint is liable to be anchylosed in various positions which incapacitate it. In the diagnosis of these deformities it is important first to determine the relation of the head of the femur to the acetabulum. This may be done by the method given (p. 131).

---

[1] N. M. Shaffer.

[2] T. McL. Tiffany.

[3] E. D. Hudson.

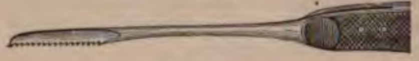
[4] G. Buck.

[5] J. R. Barton.

If the hip-joint is anchylosed in a flexed position while the disease is progressing in the head of the femur and acetabulum, the only effort at reduction should be by extension with the long hip splint, for rude movements of the bone are liable to aggravate the caries. If the disease has ceased, and the femur is fixed in an unnatural position by fibrous anchylosis, myotomy should be performed, and subsequently reduction should be attempted by force applied under an anæsthetic. If the anchylosis is osseous, and the distortion disabling, operative measures are justifiable.

1. Division of the neck, subcutaneously,[1] is made as follows: Recognize the top of the trochanter, and enter the knife just above it in the direction of the neck; open the capsule and fully expose the bone; then pass the saw (Fig. 977) along this incision, which must be maintained patulous, until the blade rests upon the neck; with a few passes the bone is divided at right angles to its axis; the saw is then withdrawn, the wound closed, and the limb brought into a proper position, and fixed on a splint. The antiseptic agents protect the wound from the dangers of suppuration.

Fig. 977.

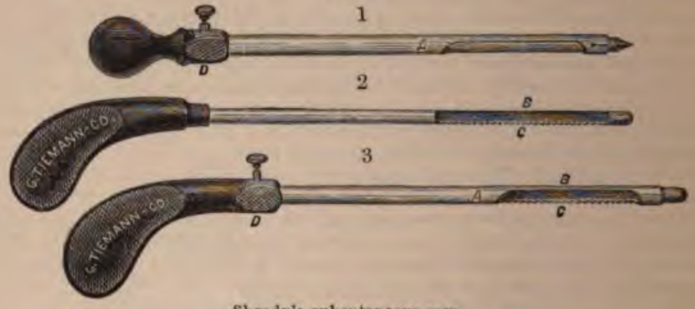


Adams's saw.

An ingenious instrument has been devised[2] which combines a subcutaneous saw, knife, and bone rasp.

It consists of a trocar, fenestrated canula, 1 (Fig. 978), and a staff, 2, with handle and blunt extremity; a portion of this staff at a short distance from the extremity is flattened, one edge, *B*, being made into a knife-blade, and the other edge, *C*, being provided with saw teeth; this staff, 2, is intended to replace the trocar in the canula after the latter is introduced; when in position, 3, either the saw, *C*, or the knife, *B*, edge of the shaft, according to the way the latter is turned, corresponds with the opening in the canula; the saw or knife can then be worked to and fro within the canula by a piston-like movement, the canula being steadied by grasping the flange, *D*, at its base; if it be necessary to work the instrument as an ordinary blunt-pointed sheathed saw or

Fig. 978.



Shrady's subcutaneous saw.

---

[1] W. Adams.

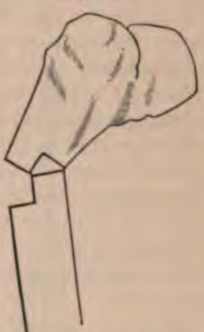
[2] G. F. Shrady.

knife, the shaft can be fixed in the canula and made into one piece by a thumb-screw in the handle. All that is necessary in using this saw is to thrust the trocar and canula into the limb, the fenestra of the canula being alongside of the bone upon which the operation is to be performed. The trocar is then withdrawn, the staff introduced in its place, 3, and worked as already described.

2. Linear and cuneiform section has frequently been made between the trochanters for true anchylosis; the operation has proved entirely successful both in regard to safety and the usefulness of the limb. The indication for resection at this point is the preservation of the insertion of the psoas magnus and iliacus internus muscles, attached to the lower fragment, for the purpose of flexion; the section has been made so as to remove a semicircular piece thus, ⌒ with its concavity downward, and, by rounding off the upper end of the lower section, creating a natural joint.[1]

3. The shaft below the trochanters has been divided both by linear and cuneiform section. The linear section is preferable,[2] and is very easily performed. The patient is placed upon the opposite side, so as to make the bone to be operated upon prominent. An incision should be made down to the bone along the shaft at the point where section is to be made. Pass a chisel of the proper width down to the bone along the knife; then change its position so that the edge shall be transverse to the long axis of the bone; now with the mallet drive the chisel through to the inner wall, which is to be fractured by moving the knee inward. The limb should be placed in the straight position, and dressed antiseptically.

Fig. 979.

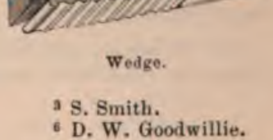


Section of femur forming a half tenon.[3]

Section of the bone has been made so as to form a half tenon (Fig. 979), the object being to provide against the displacement liable to occur after linear section. Section was made with subcutaneous saw (Fig. 978) passed along the cut made to the bone, first of the posterior, and then of the anterior wall, but at an interval of an inch; this intervening space is fractured, and the limb placed in proper position.[3]

The lower jaw may be anchylosed by cicatrices on one or on both sides. If its movements are too much restricted, an effort should be made to open the mouth by means of an instrument which describes the same curve in opening the blades as the jaw itself, and makes pressure upon the teeth directly upwards and downwards.[4] The blades should be covered with lead, or gutta-percha, to protect the teeth, and the distending force may be a screw working vertically at the external ends of the blades,[5] or by a wedge propelled by a screw (Fig. 980).[6] In applying these forces the process of dilatation should be very slow, the instrument being

Fig. 980.



Wedge.

---

[1] L. A. Sayre.
[2] F. D. Gant.
[3] S. Smith.
[4] J. L. Little.
[5] Rozer.
[6] D. W. Goodwillie.

repeatedly removed and reinstated as far as possible, in order to secure the support of as many teeth as are exposed. If the anchylosis is limited to one side and is unyielding, section of the bone should be made at the anterior margin of the cicatrix, which will enable the patient to use the free portion of the jaw. This section may be a simple division of the bone;[1] or to more effectually prevent reunion, a wedge-shaped piece may be removed,[2] three-quarters of an inch wide above and an inch below.

CHAPTER LXVI.

COMPENSATIVE APPLIANCES.

OPERATIVE surgery may not only fail to correct deformities, but in its efforts to save life may sacrifice useful parts, and leave the patient with maimed or defective limbs. The application of apparatus to compensate the loss of parts may be regarded as the fulfilment of the final obligation of the surgeon to the patient. Too often this most important duty is either imperfectly performed or entirely neglected. But in the present advanced state of mechanic art the surgeon is culpable who does not exhaust its resources in the effort to restore both the function and the symmetry of lost parts. It is the duty of every surgeon, therefore, to have that knowledge of compensative appliances which will enable him to prepare the maimed limb for the best possible apparatus, and to guide the patient to a judicious selection.

Compensative appliances[3] should be based upon the philosophical and scientific indications of each case, anatomically and physiologically considered. The supplemental apparatus, intelligently and artistically constructed and adapted, should restore lost or crippled parts to their normal condition and usefulness as nearly as possible. It is most important to bring mechanical surgery within the circle of professional interest and pursuits; for an improved amputation is of no value to the patient if it is abandoned to the non-professional, ignorant, and unappreciative for its ultimate treatment. Apparatus for palliative remedial, or compensative purposes, as for diseased joints, lesions of nerves, deformities, ununited fractures, resections and amputations, can be safely and consistently entrusted to well educated and experienced physicians and surgeons, who are qualified to analyze the character of the case, and to perceive and define what is essential in apparatus to fulfil specific indications. This requirement becomes imperative when apparatus is intended to supply, or reinforce, physiological functions of limbs and parts rendered temporarily helpless or useless from nerve lesions, extensive injury, and deformity. The numerous and multiplying cases of resections of the superior and inferior extremities, as alternatives for amputations, furnish occasion for the interposition of professional knowledge and dexterity to sustain and justify those operations by the use of legitimate apparatus.

The following principle should always govern in the selection of prothetic apparatus, namely, in construction, the mechanism should so conform to the anatomy of the lost part that all of the normal functions will be as exactly reproduced as possible.[1]

---

[1] Rizzoli.

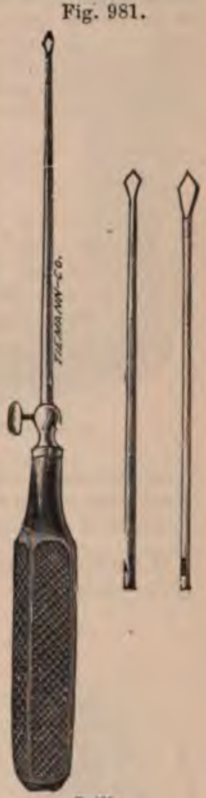
[2] F. Esmarch.

[3] E. D. Hudson.

I. PSEUDARTHROSIS.

The failure of ossific union of the ends of the bones after fracture may result in (1) union by fibrous tissue; (2) extreme mobility without union; (3) a rounded and pointed condition of the fragments which are connected by fibrous bands; (4) a dense capsule containing fluid and the ends of the bones round and smooth, false joints. The causes of non-union are numerous, and should be thoroughly studied in each case. It may be due to a want of proper apposition, or syphilis, or drunkenness, or general feebleness. In the treatment, the existing cause must, if possible, first be removed. The subsequent measures usually adopted generally have the following order:—

Fig. 981.



Drills.

Friction of the fragments is produced by rubbing them together briskly, and then the parts are kept for a time in a state of rest; or the patient is allowed to move the limb slightly.

The drill is most useful in complete fracture.[2] The common drill (Fig. 981)[3] may be employed, which works slowly owing to its half-rotation. A much more perfect drill has been devised,[4] which rapidly rotates on its axis by the mere opening and closing of the hand. Operate as follows: Make a slight puncture to the bone with a sharp-pointed bistoury; introduce the drill, in such direction as to enable it to be carried through the ends of the fragments, to wound their surfaces, and to transfix whatever tissue may be placed between them, withdraw it from the bone, but not from the skin, change its direction and perforate again; repeat this operation three or four times; place the limb in a condition of perfect rest, with a well-applied gypsum bandage, and maintain this dressing for three weeks.

Subcutaneous section of the ligamentous structures may be safely made with a narrow-bladed knife; an effort should be made to separate these tissues from the ends of the bone. The gypsum dressing must be applied.

Resection and suture of the extremities of the bones is followed by immediate results, but the operation has all the features of a compound fracture, and should not be practised in the thigh. Make an incision down upon the body, dissect out the two fragments, excise them, perforate close to the end, pass a firm silver wire and twist the ends together;[5] the antiseptic dressings must be used, as they render this operation free from dangerous suppuration.[6]

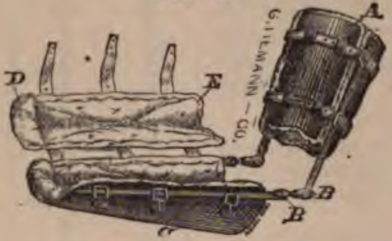
In cases which resist all these measures, or which are not adapted for such treatment, the last resource is the application of suitable apparatus which will enable the patient to use the limb. It often happens that under such treatment the patient regains vigorous health and the bones become firmly consolidated. It is a question yet to be determined whether these appliances ought not to be far more generally employed in place of the preceding operations.

---

[1] E. D. Hudson.
[2] W. Detmold.
[3] D. Brainard.
[4] G. F. Shrady.
[5] T. Billroth.
[6] J. Lister.

In the application of such apparatus, remember (1) that the pressure at the seat of fracture is as great as can be borne without inflaming the skin; (2) that in the lower extremities the weight of the body is sustained by the upper part of the hollow splint, just as a stump is sustained in an artificial limb after amputation; the upper strap should, therefore, be firmly drawn when the patient is about to walk, but slackened when in bed or sitting up in a chair; (3) when worn for several months the inside lining and stuffing should be renewed, so as to give accurate support; (4) when, from union occurring, it is proposed to lay aside the splint, let it be taken off at night for ten days, or whilst sitting up in a chair, before any attempt is made to walk without it.[1]

Fig. 982.



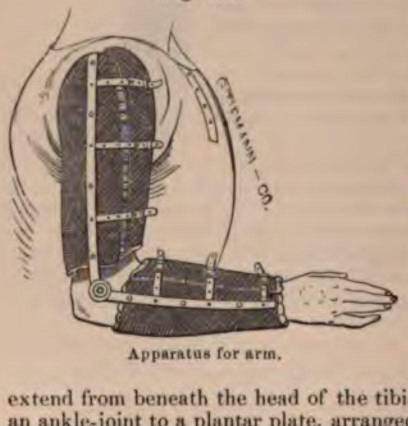
Apparatus for forearm.

The ulna and radius occasionally fail to repair after fracture, when an apparatus like the following may be usefully employed (Fig. 982).[1]

It consists of, *A*, piece accurately embracing the arm; *B*, joint for flexion and extension of forearm at elbow; *B*, pivot-joint permitting rotation of head of radius in semi-pronation and supination; *C*, ensheathing piece for forearm; *D*, a thick pad to press on styloid processes of ulna and radius at their carpal surfaces, so as to preserve the parallelism of these bones.

The humerus is more often the locality of non-union than any other bone. An apparatus for its relief should fit closely to the rotundity of the shoulder, and should also embrace the forearm (Fig. 983), being accurately jointed to the elbow.

Fig. 983.



Apparatus for arm.

The tibia rarely remains ununited after the application of the drill and moderate exercise with an immovable apparatus. If non-union continue, apply a more durable apparatus.

This should consist of the following parts (Fig. 984):[1] *A*, support at middle of thigh; *B*, knee-joint in side-irons; *C*, main support of the body by accurate adjustment below the tubercle of the tibia; *D*, ankle-joint and boot. Or, the splint[2] may extend from beneath the head of the tibia to the malleolus, and continue from an ankle-joint to a plantar plate, arranged one inch from beneath the foot, and allow the foot to be attached to it to overcome the shortening; strong leather bands and a graduated splint confine the limb and fragments of bones in position, while a padded leather band beneath and steel straps, with joints at the knee, extend from the leg-bonnet up the inner and outer aspects of the thigh, to attach to a thigh case; this affords efficient counter extension and support (Fig. 986).

---

[1] H. H. Smith.

[2] E. D. Hudson.

Fig. 984.

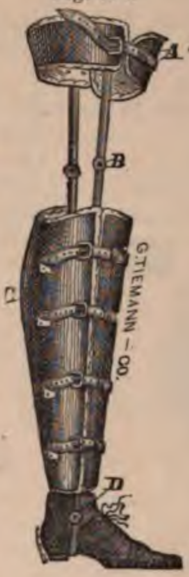
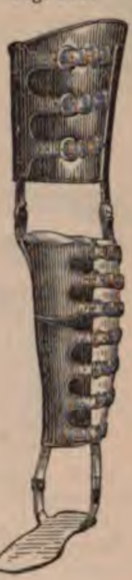


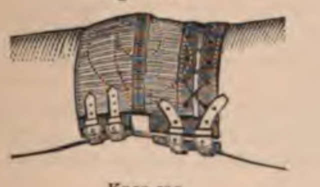
Fig. 985.



Apparatus for leg.

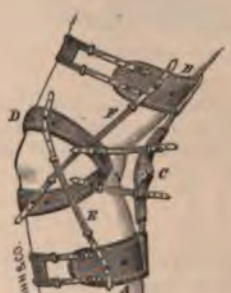
The patella rarely unites by bone, and there is great liability that by sudden flexion of the leg the fibrous adhesions will be ruptured. This defect should now be treated by wiring the patella, after denuding the edges of the fragments. If the patella is united by a very weak ligament, it is so impaired in function that the power of extending the leg upon thigh is greatly diminished, and sometimes nearly lost. This function may be preserved, when slightly impaired, by a simple apparatus, consisting of a leather knee-cap, strengthened posteriorly, and maintained in position by buckles. If the loss of power is very disabling, the apparatus should be more firm, and have, *a*, hinge-joint posteriorly, *C* (Fig. 986),[1] strong bands, *A B*, a ring acting over the anterior part of the joint *D*, with lateral bands *F F*. When the function is lost by separation of the fragments, the apparatus must completely compensate the loss of power of the quadriceps extensor (Fig. 994) by a spring at the joint.

Fig. 986.



Knee cap.

Fig. 987.



Apparatus for patella.

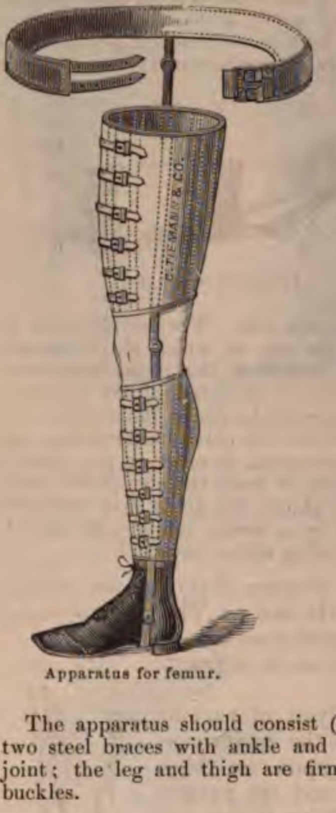
A very useful apparatus (Fig. 986) consists of a cap of buckskin or satin jean, adjustable to the knee by buckles or laces, and provided with a pair of coaptation pads, to retain the newly united patella in place; these pads are arranged to approximate by drawing on laces of the cap; it affords the patient exercise of the knee-joint, the best guard against the danger of anchylosis, at the same time preventing any undue strain on the newly united upper fragment of the patella.

---

[1] F. Bacon.

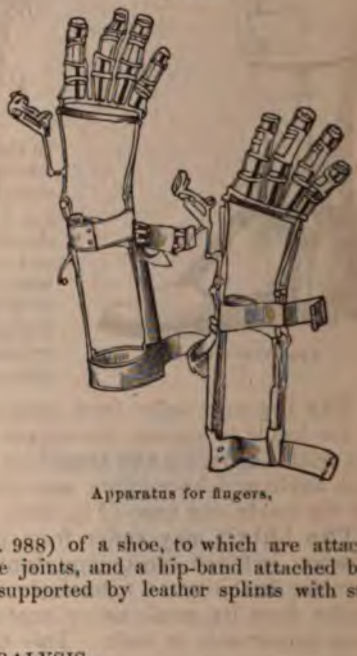
The femur, next to the humerus, most frequently fails of union. The disabling effect of this result is of the most serious character. Of the various operative methods of attempting to secure union all should be discarded in favor of the splint, which enables the patient to resume active exercise.[1]

Fig. 988.



Apparatus for femur.

Fig. 989.



Apparatus for fingers.

The apparatus should consist (Fig. 988) of a shoe, to which are attached two steel braces with ankle and knee joints, and a hip-band attached by a joint; the leg and thigh are firmly supported by leather splints with stout buckles.

II. PARALYSIS.

The various forms of paralysis affecting the extremities may be relieved by apparatus.

The fingers occasionally suffer paralysis of the extensor muscles, giving only flexion of the fingers. This condition may be greatly relieved by a light apparatus (Fig. 989), which constantly extends the fingers and wrist.[1]

The wrist may fall into the position of flexion, wrist-drop, from paralysis of the extensors of the carpus. This mal-position is readily rectified by a simple instrument, which makes elastic pressure on the thenar and hypothenar eminences (Fig. 990).

---

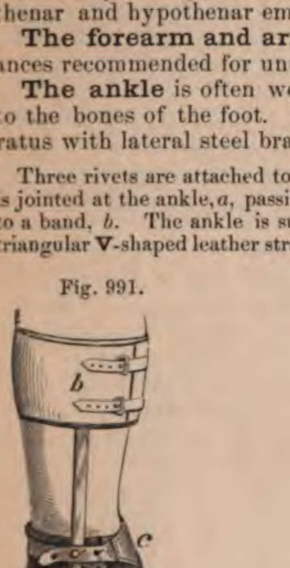
[1] E. D. Hudson.

The forearm and arm affected by paralysis require the appliances recommended for ununited fracture.

The ankle is often weak from paralysis of the muscles attached to the bones of the foot. The joint is easily strengthened by apparatus with lateral steel braces fastened to the shoe (Fig. 991).

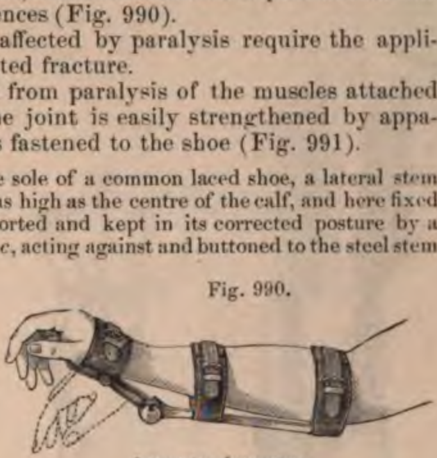
Three rivets are attached to the sole of a common laced shoe, a lateral stem is jointed at the ankle, *a*, passing as high as the centre of the calf, and here fixed to a band, *b*. The ankle is supported and kept in its corrected posture by a triangular **V**-shaped leather strap, *c*, acting against and buttoned to the steel stem on the opposite side. The best direction for selecting the side on which the instrument should be applied, is, that if the outer ankle has a tendency to eversion, the apparatus should invariably be placed to the inner side, and *vice versa*. In obstinate cases it is made with double stems, in order to give greater security, and to keep the sole in a strictly horizontal plane; the ankle may be further protected by a small, round, soft pad, to prevent chafing against the steel.

Fig. 991.



Apparatus for ankle.

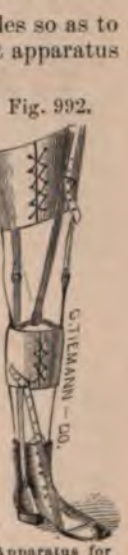
Fig. 990.



Apparatus for carpus.

The leg may suffer from paralysis of some of its muscles so as to be too feeble to sustain the weight of the body. The best apparatus has, with a shoe, leg and thigh belt, lateral steel braces, with ankle and knee-joints, and elastic bands supporting the ankle and knee (Fig. 992).

Fig. 992.



Apparatus for paralysis of leg.

The thigh may suffer from paralysis of various muscles, but the most important is the quadriceps femoris; inability to extend the leg upon the thigh results from its paralysis or rupture, and the patient is no longer able to walk. This condition is relieved by an apparatus (Fig. 993). The instrument consists of steel supports, and strong elastics attached to cords, working upon eccentric leverages; the knee is entirely free from all pressure, and after the leg is bent by the flexors, extension of the leg upon the thigh promptly occurs.

In cases of infantile paralysis, with atrophy and shortening of the limb, it is very difficult to supplement the loss by any ordinary means. The limb not only has to be strengthened, but also to be lengthened, in order to restore its function. This may be effected by the following apparatus (Fig. 994), namely, two upright steel bars, *K*, attached to the shoes, pass up either side of the leg nearly to the knee; they are then curved backward to the middle of the popliteal space, where they unite in a stop joint, *A*, which allows partial bending of the knee; from this point two lateral steel bars, *K*, diverge and pass upon either side of the thigh, the external as high as the trochanter major, *G*, and the internal, nearly to the groin; to the upper ends of these bars two bands are attached, the posterior being thickly padded and resting under the tuber ischii, and the anterior, *D*, of lighter material; a knee-cap, *M*, maintains the leg in position by means of lateral straps; two light bands pass around the leg, *C*, and the thigh, *B*; the shoe has an inside elevated sole to which the foot is attached, and which permits support on the foot in the act of walking. The effect of the apparatus is to render the defective limb of the same length as the well limb; the spine being thereby straightened, and the steps made equal; the body is carried on the posterior band. This apparatus is adapted to cases of hip-joint disease in the stage of recovery, for slight traction may constantly be made.

Fig. 993.

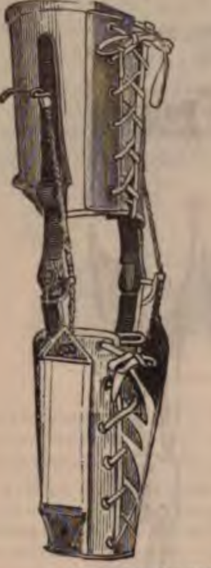
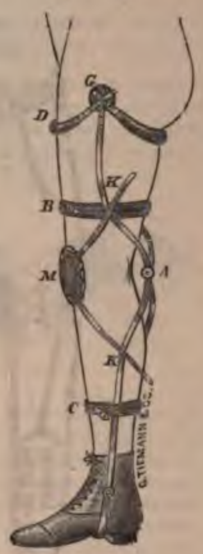


Fig. 994.



Apparatus for paralysis of thigh.

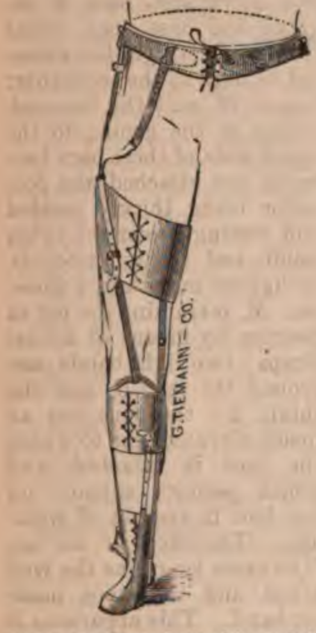
The thigh and leg affected by paralysis of the muscles require the same apparatus as the preceding, but it should be extended so as to embrace the hip by a belt (Fig. 995) to which the elastic straps are attached.

Both lower limbs may be paralyzed, and yet the patient may be enabled to resume the upright position, and walk about. The apparatus is simply the latter instrument made double (Fig. 996).

III. DANGLE LIMBS.

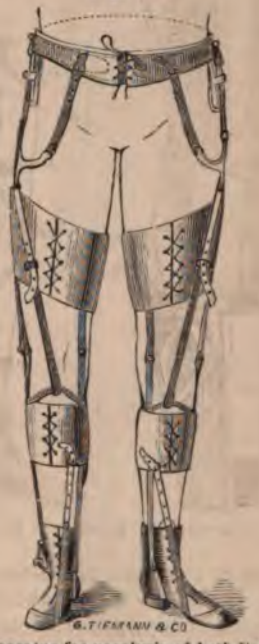
Anchylosis of the knee-joint remedies certain forms of infantile paralysis where the limb is paralyzed throughout its entire extent. The muscles of the thigh and hip equally with those of the foot and leg are so atrophied that the patient has no power to walk, or walks with the greatest difficulty. In some cases the flexor muscles act feebly, and not unfrequently the leg is flexed permanently on the thigh. These patients usually walk with a crutch, and the leg is allowed to dangle helplessly. Certain patients support the knee with the hand, and in this manner are able to walk. The treatment of these cases has been amputation at or below the knee, and the application of an artificial limb. But a more satisfactory operation is excision of the knee, and permanent anchylosis of that joint. This operation is performed with antiseptics, in the usual manner, and

Fig. 995.



Apparatus for paralysis of leg and thigh.

Fig. 996.



Apparatus for paralysis of both limbs.

without any unfavorable symptoms. The limb now being straight, and the knee fixed in its position, the patient can walk with but a slight limp.[1]

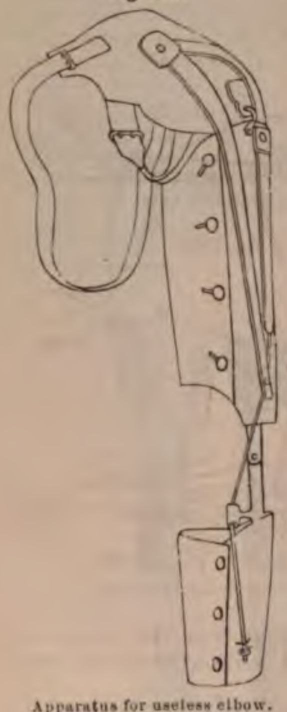
The flail-like movement of the upper extremities, after resection of bones and exsection of joints, frequently renders them entirely useless without apparatus, but with this, suitably constructed and adjusted, these limbs become very serviceable. The apparatus should consist of arm and forearm pieces, with a hinge-joint at the elbow (Fig. 997); the whole apparatus being maintained in connection with the trunk by shoulder-straps.

IV. ARTIFICIAL LIMBS.

The application of artificial limbs to supplement the losses occasioned by amputation must be regarded as the highest expression of mechanical art. The perfection of the mechanism of these appliances, when produced by skilled labor, is not excelled in any branch of human

[1] S. Smith.

Fig. 997.



Apparatus for useless elbow.

invention. Hands and arms, feet and legs, may now be obtained which are scarcely less useful, and are often even more ornamental, than the original limbs. And these appliances are now within the reach of the most humble person. The surgeon can no longer ignore these facts and discriminate between the rich and poor man's stumps; nor can the selection of these appliances longer be left to the patient himself, who is liable to be imposed upon by mere manufacturers, having no adequate knowledge of the proper functions of the apparatus which they are required to supply. It not unfrequently happens that the surgeon does not so fully understand the mechanism of these appliances as to be qualified to advise in their selection. Such ignorance implies also a want of good judgment in the formation of the stump to which the appliance is to be adjusted, and has received judicial condemnation. The important principle to be constantly borne in mind, in adapting stumps to artificial limbs, is the necessity of adequate leverage, and a well-composed and compact covering.[1]

The fingers, individually or as a group, may be supplied with apparatus which admits of seizing and grasping. The fingers should be so placed and moved as to enable the normal thumb to oppose each one at all of its articulations, and when the fingers are closed the thumb should be in position to close over the first and second. If the thumb alone is lost, the substitute should be adapted to oppose the fingers (Fig. 998). If the thumb and forefinger are supplied, they must be in a state of opposition for the purpose of grasping, but the latter must be susceptible of easy extension (Fig. 999).

Fig. 998.

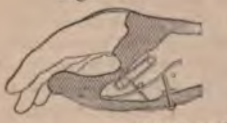
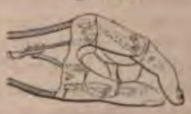


Fig. 999.



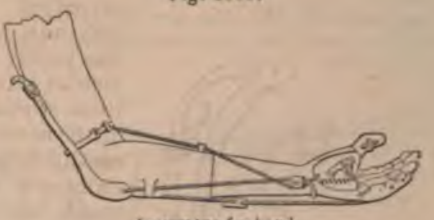
Apparatus for fingers.

The hand and forearm are best supplemented when the stump is made above the wrist-joint and through the lower portion of the shaft of the ulna and radius; the bulbous extremity of the radius, when the stump is at the wrist-joint, is not adapted to the form of socket of the artificial limb. The position of the fore and second fingers and thumb, should be as far as possible that of opposition when closed. Pronation and supination are secured in the forearm, and the flexion and extension of the carpus are affected by cords acting through springs (Fig. 1000). The cords may be acted upon by the movements of the opposite shoulder (Fig. 1001).

---

[1] E. D. Hudson.

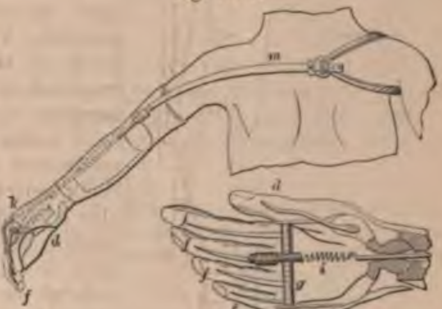
Fig. 1000.



Apparatus for hand.

The spiral spring, *i* (Fig. 1001), draws the fingers, *f*, constantly towards the thumb, *d*, and retains any article placed within the hand and between the thumb and fingers; the hand may be opened by a motion of the opposite shoulder drawing on the shoulder strap, *m*, and cord, *k*, or by extending the artificial hand and arm; the fingers are constructed on the metallic bar, *g*.

Fig. 1001.

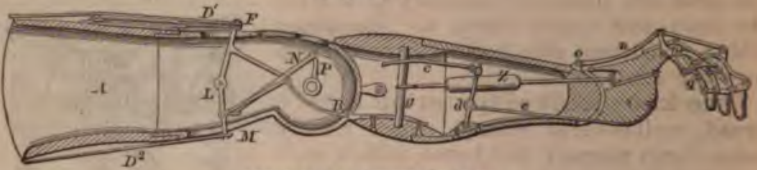


Apparatus for hand and arm.

The arm and forearm, with the hand, are supplied, in amputations in the arm, by apparatus which derives its motion from the stump; the backward motion extends, and the forward motion flexes the joints of the arm and forearm.

In these cases the upper arm consists of a socket to receive the stump of the limb, and is secured by straps to the person with a certain degree of rigidity; the anterior and posterior tendons or rods have a firm attachment at or near the shoulder, pass along or through the upper section, and are attached to such points on the forearm that, as one or the other is tightened, the forearm is flexed or extended; in some cases the oscillation of the elbow articulation is obtained by cords which have direct or intermediate attachment to the forearm, in others the cords or bars move a toothed wheel which engages a pinion on the elbow axis and gives motion to the forearm; the backward motion of the stump tends to strain the anterior tendon, which is so connected to the forearm behind the elbow-joint as to extend the forearm; the forward motion of the stump strains the posterior tendon which connects to the forearm in front of the articulation, and thus flexes it as the stump is moved forward. These motions follow the natural ones, as, for instance, in the act of raising the hand to the mouth it is usual to oscillate the arm forward on the shoulder as a pivot, and backwardly as the hand descends; in the natural arm the pivotal position of the forearm is varied so as to cause the arm to swing in an arc which will bring the hand to the required place, as the mouth; in the artificial arm the motion on the shoulder is the generator of the motion on the elbow, and a certain amount of practice and adjustment is required to proportion the parts so that the consentaneous action of the parts which produce the compound motion may, without apparent constraint or indecision, land the hand at the object. When the trunk of a person affords points of attachment for the flexor and extensor straps, the motions of the shoulder itself, relatively to the thorax, and involving the clavicle and scapula, may be made to assist in executing the motions required. The primary motion of the stump having been communicated to the forearm by the means described (or other special devices which are various and very ingenious). the motions of the hand are derived from that of the forearm by means of tendons, slides, or other attachments (Fig. 1002).

Fig. 1002.



Apparatus for forearm and arm.

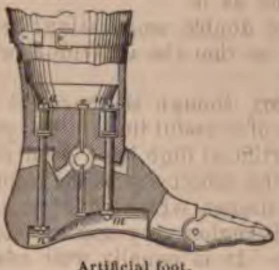
The toes may be supplemented by artificial means, but, in general, a boot provided with a heavy sole answers every purpose in progression. The same is true of amputation of the metacarpus.

The foot cannot be adequately substituted when the amputation is below the ankle-joint.

The tarso-metatarsal and medio-tarsal[1] amputations will not hereafter be performed where there exist intelligent and humane regard for improved surgery, and the greatest benefit of the sufferer; the operations are in no respect conservative nor creditable to the surgeon who makes them.[2]

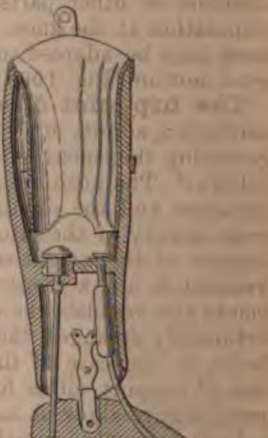
The ankle-joint stump affords space, firmness, and leverage for the artificial foot, and should be preferred whenever any considerable portion of the foot must suffer amputation, and whenever any of the soft tissues of the heel, or beneath the malleolus, or of the dorsum of the foot are sufficient to constitute either a single or double flap, even if necessary to form the cicatrix over the conical part of the base of the stump.[2] The appliance should have only flexion and extension at the ankle-joint (Fig. 1003), and flexion of the toes.

Fig. 1003.



Artificial foot.

Fig. 1004.



Artificial leg.

The leg-stump may be formed at any part, but the apparatus is the same in each case. The foot should be of the same mechanism as in the ankle-joint stump, namely, a socketed axial bolt passing transversely through it, giving only flexion and extension (Fig. 1004). The construction of the leg-piece is designed to give lateral support by a well-shaped and fitting socket; a thigh-piece with joints in the steel side pieces is necessary to sustain the limb, and elastic straps are sometimes added which are attached to a yoke strap over the shoulder.

---

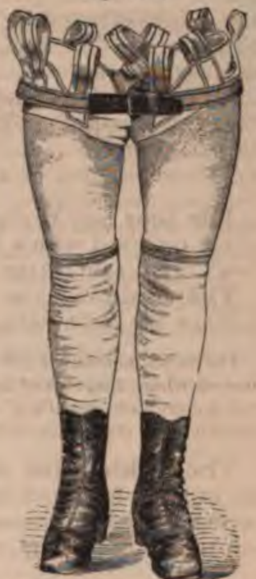
[1] Chopart.

[2] E. D. Hudson.

The knee-joint amputation leaves a broad, well-covered stump, which readily takes direct support, and hence, with a well-adjusted appliance, is extremely serviceable. The foot and leg pieces are the same as those already given. The knee-joint may be perfect in the motions of flexion and extension, and the padded socket should be exactly adapted to the form of the stump. The thigh should lace up in front, and straps may be added to sustain the whole upon the shoulder. The same apparatus is necessary when the amputation is at the point of election, for by flexion of the short stump the bearing is taken on the condyles of the femur in the same manner as in knee-joint amputation.

The thigh amputation requires a socket extending to the hip, with bands attached which may be applied over the shoulder to support the apparatus. The construction of other parts is the same as in amputation at the knee. In cases of double amputation these appliances may be adapted to both legs, so that the individual will have good motion (Fig. 1005).[1]

Fig. 1005.



Artificial legs for both limbs.

The hip-joint disarticulation, though the severest form of mutilation, admits of the application of a useful limb. The principles governing the construction of the artificial limb have been stated as follows:[2] The position and size of the tuberosity of the ischium, the thickness and the elasticity of the tissues which cover it, the very great density of the skin render this region very appropriate for the support of the weight of the body. It is equally well adapted to transmit it, and a proper regard for this governs the prosthesis, and should also regulate the operative procedure. Nevertheless, however fortunately arranged the tuberosity of the ischium seems to be, it forms, in the case of the loss of a lower extremity, a very narrow base of support, either for standing or walking; it is not sufficiently prominent to allow us to attach the artificial limb; it is immovable, and consequently incapable of communicating movement; no natural intermediate substance does effectually deaden the shock caused by the artificial limb coming in contact with the ground. In the normal condition the lower extremities serve as a counterbalance for the upper part of the body and broaden its seat. The coxo-femoral disarticulation having been performed on one side, the body ceases to be balanced, and rests merely on a bony protuberance; large, it is true, but convex, and merely touching the plane of support by a single point; and a simple keel adjusted to this tuberosity would leave the patient in continual vacillation. Nature has admirably arranged that the weight of the body pass in a straight and central line, because there are distributed about it contractile agents which maintain the equilibrium; but we are deprived of these remarkable agents, and in order to supply the mechanism of the natural limb, it is necessary that the means of prosthesis embrace the whole space occupied by them. Now, the space required for the attachment of the artificial limb is not reduced to the cylindrical circumference of the thigh; it embraces the surface of the pelvis to which are inserted the muscles, which, while standing or walking, assure a normal harmony between the pelvic bones and the femur.

---

[1] E. D. Hudson.

[2] M. Foulliay.

The apparatus made in accordance with these principles consists of a gutta-percha bonnet covering the entire region of the stump, and retained in place by a broad belt around the body. To this bonnet is attached the artificial limb by means of a joint, which gives adequate motion for progression.

INDEX.

ABDOMEN, anatomy of, 459, 470.
  herniæ of, 545.
  operations on, 467.
  parietes of, 459.
  viscera of, 471.
  wounds of, 459.
Abdominal aneurism, 307.
  aorta, ligation of, 307.
  herniæ of, 545.
  section of, 467.
Abnormal anus, 502.
Abscess of abdominal walls, 461.
  of alveolar process, 429.
    antrum, 433.
    brain, 340.
      operation, 341.
    breast, 760.
    cæcum, 505.
    kidney, 636.
    liver, 535.
    nasal fossæ, 583.
    peritoneal, 466.
    pharynx, 450.
    salivary glands, 434.
    spine, 176.
    tongue, 441.
    tonsil, 437.
    umbilicus, 462.
    vermiform appendix, 504.
Acid, boracic, 82.
  carbolic, 93, 98.
  salicylic, cream, 82.
Acne rosacea, 392.
Acromio-clavicular dislocation, 146.
Actual cautery, 47.
Acupressure, 44.
  by forceps, 45.
    torsion, 45.
    wire, 45.
  in aneurism, 668.
Acupuncture, application of, 400.
Affections, nervous, after wounds, 111.
Age in operations, 27.
    prognosis, 27.
Agents, precautions in the use of antiseptic, 98.
Air, disinfection of, 76.
  in the veins, 43.
Ala of nose, 579.
Alimentation, rectal, 516.
Alveolar process, abscess of, 429.
  dentigerous cysts of, 430.
  vascular growths of, 423.
  warty growths of, 430.
Ammonia in collapse, 63.
Amputation, at ankle-joint, 799.
  at elbow-joint, 784.
    hip-joint, 813.
    knee-joint, 805–813.
    shoulder-joint, 786–790.
  by anterio-posterior flaps, 412.
    bilateral flaps, 805.
    double flaps, 816.
    lateral flaps, 812–815.
    periosteal flaps, 771.
    rectangular flap, 807.
    single flap, 815.
  circular, 810, 816.
  division of bone, 597.
  of arm, 785.
    fingers, 776.
    foot, 790–796.
    forearm, 782.
    leg, 804–807.
    medio-tarsal, 796.
    metacarpal bones, 781.
    metatarsal, 792.
    penis, 715.
    phalanges, 790.
    tarsus, 798.
    thigh, 811, 855.
    thumb, 777.
    toes, 790.
  osteoplastic, at ankle-joint, 802.
    at knee, 809.
  oval operation, 816.
  supra-malleolar, 803.
  Syme's, 800.
  through metatarsal bones, 792.
  time of, 766.
  wound, care of, 772.
Amygdalotomy, 438.

INDEX.

- Anæsthesia, 48.
  - general, 48.
  - local, 52.
  - by ether, 53.
    - hydrochlorate of cocaine, 53.
    - ice, 53.
    - liquefied carbolic acid, 53.
- Anæsthetics, 48.
  - chloroform, 50.
  - nitrous oxide, 49.
  - rapid respiration, 52.
  - sulphuric ether, 49.
- Anchylosis, causes of, 836.
  - of elbow-joint, 837.
    - hip-joint, 841.
    - knee-joint, 838, 850.
    - phalangeal-joints, 837.
    - shoulder-joint, 838.
    - wrist-joint, 837.
- Aneurism, 265.
  - abdominal, 307.
  - arterio-venous, 262.
  - by anastomosis, 220.
  - cirsoid, 263.
  - gluteal, 307.
  - ileo-femoral, 307.
  - needles, 280.
    - use of, 280.
  - popliteal, 307.
    - symptoms, 265.
    - treatment, 265.
  - by acupressure, 268.
    - compression, 268.
    - constriction, 268.
    - elastic bandage, 265.
    - electrolysis, 266.
    - flexion, 266.
    - foreign bodies, 266.
    - injection, 265.
    - ligation, 268, 278.
    - manipulation, 265.
  - varicose, 269.
- Aneurismal varix, 262.
- Angeioma, plexiform, 275, 442.
- Angeiomata, cavernous, 274.
- Ankle-joint, amputation at, 799.
    - osteoplastic, 802.
  - braces for, 181.
  - caries of, 180.
  - disarticulation at, 779.
  - dislocations of, 154.
    - compound, 154.
  - excision of, 215.
- Anthrax, 386.
  - seat of, 387.
- Antisepsis, new obligations imposed by, 20.
  - principles of, 22.
- Antiseptic agents, 76–85.
- Antiseptic dressing in aseptic surgery, 24, 283.
  - method, 76–85.
- Antrum, abscess of, 595.
  - anatomy of, 433, 595.
  - dropsy of, 595.
- Anus, abnormal, 527.
  - absence of, 524.
  - anatomy, 524.
  - and rectum, 528.
  - artificial, in intestinal wounds, 401.
  - contraction, 524.
  - exploration of, 524.
  - fissure of, 529.
  - fistula in, 530.
  - imperforate, 524.
  - vaginal fistula in, 527.
  - vesical fæcal fistula in, 428.
- Aorta, abdominal, ligation of, 307.
  - aneurism of arch, 284.
- Apnœa, 60.
- Apparatus, compensative, 844.
  - for dangle limbs, 850.
    - femur, 848.
    - humerus, 846.
    - paralysis, 848.
    - patella, 847.
    - tibia, 849.
    - ulna and radius, 846.
    - ununited fractures, 845.
  - plastic, 73.
- Applications, endermic, 399.
  - external, 65.
- Arch, deep palmar, 306.
  - superficial palmar, 305.
- Arm, amputation of, 785.
  - artificial, 853.
  - paralysis of, 849.
- Arterial compression, 40.
  - by fingers, 41
    - key, 41.
    - ligature, 42.
    - tourniquet, 41.
  - thrombosis, 263.
- Arteries, acupressure, 44, 225.
  - compression of, 45.
  - contusion of, 258.
  - diseases of, 263.
- Arteries, general operations on, 277.
  - injuries of, 258.
  - ligation of, 278.
  - penetration with instrument, 259.
  - rupture of, 258.
  - special treatment, 259.
  - wounds of, 215, 216.
- Arterio-venous aneurism, 262.
- Arteriotomy, 278.
- Artificial limbs, 851.

- Artificial respiration, 60.
  - methods of, 61.
- Ascites, tapping in, 443.
- Aseptic surgery, basis of, 24.
  - general principles governing, 24.
- Aspiration of intestines, 497.
  - hydatid tumor, 542.
  - hydronephrosis, 640.
- Aspirator, 641.
- Assistants, duties of, 88.
  - preparation of, for operation, 88, 76.
- Astragalus, dislocation of, 154.
  - resection of, 213.
- Atheroma, 264.
- Atomizer, 76.
- Atrophy of nails, 394.
- Axillary artery, aneurism, 297.
  - ligation of, 298–300.
  - operation, 298.

- BANDAGES, circular, 70.
  - double-headed, 72.
  - elastic, 39.
    - application, 39.
    - in aneurism, 266.
  - figure-of-eight, 72.
  - gypsum, 74.
  - recurrent, 73.
  - roller, 70.
  - silica, 75.
  - spica, 71.
  - spiral, 71.
  - starch, 74.
  - T, 72.
- Bichloride of mercury, 77, 78, 98.
- Bilateral lithotomy, 667.
- Bistoury, laryngeal, 608.
- Bladder, anatomy of, 648.
  - aspiration of, 655.
  - calculi of the, 658.
  - exploration of, 646.
  - extroversion of, 650.
  - foreign bodies in, 657.
  - gall-bladder, anatomy of, 537.
    - in women, 676.
    - rupture of, 537.
    - wounds of, 238.
  - inflammation of, 653.
  - malformation of, 650.
  - puncture by rectum, 694.
    - supra-pubic, 694.
  - rupture of, 652.
  - tumors of, 655.
  - wounds of, 653.
- Bleeding, 62.
- Blood, injection of, 48.
- Blood-letting, 322.
- Blood-letting, local, 327.
  - cupping, 228.
  - leeching, 327.
  - scarification, 327.
- Boils, cause and treatment, 385.
- Bones, caries, 161.
  - compound fracture of, 139.
  - diseases of, 155.
  - excision of, 193.
  - fracture of, 121.
  - general operations on, 183.
  - inflammation of, 160.
  - injuries of, 120.
  - necrosis of, 163.
    - partial, 164.
    - total, 164.
  - resection of, 183.
  - rickets, 155.
  - tumors of, 156–160.
- Boracic acid, use of, 82.
- Bougies, bulbous, 687.
- Bowlegs, 832.
- Bowls, slop, 87.
- Brachial artery, anatomy, 300–302.
  - ligation of, 300–302.
  - plexus, 369.
  - resection, 369, 370.
- Brain, abscess of, 340.
  - commotion of, 333.
  - compression of, 333.
  - concussion of, 333.
  - contusion of, 333.
  - exploring, 344.
  - hernia of, 341.
  - inflammation of, 339.
  - wounds of, 334.
- Breast, abscess of, 760.
  - extirpation of, 761.
  - inflammation of, 759.
  - scirrhus of, 761.
  - tumors of, 761.
- Bristle probang, 450.
- Bronchi, anatomy of, 623.
  - foreign bodies in, 524.
- Bronchocele, varieties of, 622.
- Burns, degrees of, 382.
  - cicatricial contractions in, 406, 407.
- Bursæ, deep, 244, 245.
  - inflammation of, 244.
    - deltoid, 244.
    - ligamentum patellæ, 244.
    - quadriceps extensor, 244.
  - superficial, 245.
  - tumors of, 612.
  - wound of, 244.

- CÆCAL abscess, 504.
- Cæcum, abscess of, 505.

, anatomy of, 504.
ussusception of, 506.
ration of appendix, 504.
ds of, 504.
section, 730.
salivary glands, 434.
lus ethra, 684.
ion of, 685.
).
358.
58.
659.
Call
ent, 385.
Canalization, 81.
Cancer of the nose, 595.
    of the colon, 513.
        penis, 714.
        rectum, 522.
        rodent, 389.
        testicle, 703.
        tongue, 443.
        tonsil, 438.
            operations for remo
                447.
        uterus, 735.
Canula, care of, 620.
Carbuncle, 386.
Carcinomata, 438.
Cardia, 471.
    stricture of, 471.
Care, degree of, 19.
Caries of bone, 161–169.
    central, 162.
    external, 163.
    fungating, 169.
    internal, 163.
    of joints, 169.
        ankle-joint, 180.
        carpal joints, 181.
        hip-joint, 177.
        knee-joint, 179.
        tarsal joints, 181.
        vertebræ, 171.
    simple, 169.
    superficial, 161.
Carotid, common, aneurism of, 285, 286.
    direction of arteries, 286.
    external, ligation of, 288.
    internal, ligation of, 288–293.
        wounds of, 259.
    ligation of, 289.
    operations, 287, 288, 289.
    relations, 288.
    wounds of, 289.
Carpal joints, caries of, 181.
Case of instruments, 35.
Castration, 703.
Catch forceps, 43.
Catgut ligature, 80.
    drain, 81.
Catheter, 648.
    Bigelow's, 662.
    Mercer's, 708.
    velvet-eyed, 679.
Catheterism, prostatic, 649.
    in the female, 695.
    in the male, 649.
Catheters, 648.
    introduction of, 649.
Cauterization, 46, 401.
    actual cautery, 47, 401.
    thermo-cautery, 47, 401.
vities, dressing of, 94.
llulitis, causes, 387.
rebral anatomy, 344.
    localization, 345–347.
ain-saw, 114.
ange in dressing, 25.
anges, normal, in a wound, 22.
    abnormal, in a wound, 22.
eloid, 408.
ilblains, 381.
    treatment, 382.
loroform, 50.
    administration, 50.
Cholecystectomy, 540.
Cholecystotomy, 539.
Chondromata, 157.
Chopart's operation, 796.
Cicatrices, growths on, 407.
    warty tumors of, 408.
Cicatricial contractions, 406.
    causes, 406.
    operations for, 406–408.
    selection of methods, 407.
Cicatrix, adherent, 118.
    contracted, 119.
    defective, 118.
        prevention, 119.
    exuberant, 118.
    painful, 119.
    variations, 118.
Cicatrization, normal, 114.
Circulatory system, diseases of, 257.
    aneurism, 265.
        by anastomosis, 264.
        cirsoid, 263.
    atheroma of, 264.
    embolism of, 263.
    general operations of, 477.
    injuries of, 257.
    special operations on, 357.
    thrombosis, arterial, 263.
        venous, 268.
Cirsoid aneurism, 263.
Clamp, nasal, 587.

- Clamp, varicocele, 699.
- Clavicle, fracture of, 124, 141.
  - resection of, 209.
  - shot fracture of, 141.
- Claw nails, 396.
- Cleft palate, 422.
  - operations for, 423.
  - varieties of, 422.
- Club-foot, 823.
  - appliances for, 825.
  - rules for treatment, 824.
  - shoes, 825.
- Coccobacteria septica, action of, 23.
- Coccyx, excision of, 230.
- Collodion in wounds, 65.
- Colon, anatomy of, 508.
  - cancer of, 513.
  - resection, 514.
  - section of, 511.
  - stricture of, 509.
  - wounds of, 508.
- Colotomy, after-treatment, 513.
  - operation of, 511.
- Columna, 579.
- Compound fracture, 139.
  - antiseptics in, 95, 140.
  - indications of, 140.
  - plastic dressing in, 140.
- Compression in aseptic surgery, 24
    - after fracture, 121.
    - arterial, 40.
    - by fingers, 41.
      - key, 41.
      - ligature, 42.
      - tourniquet, 41.
  - elastic, 39.
  - in aneurism, 267.
    - methods, 224, 225.
  - in incised wounds, 304.
  - of brain, 333.
    - nerves, 282.
- Conclusion of operation, 58.
- Concussion of brain, 333.
  - of lungs, 622.
    - spine, 357.
    - symptoms, 333.
    - treatment, 333.
  - hemorrhage in, 357.
  - in railway injuries, 359.
- Conformity to established rules, 19.
- Consent to operation, 31.
- Constitution, nervous, 365.
- Constitutional diseases in prognosis, 28.
- Constriction, 46.
  - application, 46.
  - in aneurism, 268.
- Constrictor, 46.
  - artery, 46.
  - muscles, 245.
- Contusions of brain, 333.
  - of nerves, seat of, 361.
    - scrotum, 697.
    - skin, 374.
    - veins, 260.
- Convalescence, nurse, 38, 39.
  - room for, 38.
  - ward for, 38.
- Cord, spermatic, hæmatocele of, 700.
  - hydrocele of, 701.
  - varicose veins of, 701.
- Corn, treatment of, 385.
- Cranio-cerebral topography, 247-353.
- Cranium, trephining of, 344, 355.
  - contra-indications, 352.
  - indications for, 352.
  - inflammation within, 339.
  - points of, 353.
  - treatment of fracture of, 332.
- Croup, tracheotomy in, 617.
- Cuboid bone, resection of, 213.
- Cuneiform bone, resection of, 212.
- Cupping, instruments for, 327, 328.
- Cystitis, acute, 654.
  - chronic, 654.
    - irrigation in, 654.
- Cysts, dentigerous, 430.
  - ovarian, 561.
  - serous, 535.

- DAY for operations, 33.
- Decision as to operation, 30.
- Delirium nervosum, 112.
- Delirium tremens after operations, 111.
- Dentigerous cysts, 430.
- Diagnosis, elements of correct, 25.
  - history of patient, 26.
  - progress of disease, 26.
- Digital nerves, resection of, 372.
- Digits, supernumerary, 822.
  - webbed, 822.
- Diligence, what constitutes, 19.
- Disarticulation: at ankle-joint, 799.
  - at the hip-joint, 813, 855.
  - double antero-posterior flaps, 814.
  - medio-tarsal, 796.
  - metacarpal, 603-606.
  - of metatarsal bones, 790-799.
    - tarsus, 798.
    - toes, 790.
  - vertical and circular method, 814.
- Disarticulation: radio-carpal, 148.
  - tarso-metatarsal, 795.
- Disease, progress of, in diagnosis, 26.
- Disinfection of wounds, 24.
  - irrigation in, 24.
- Dislocations, 145.
  - acromio-clavicular, 146.

Dislocations, compound, 145.
    definition of, 145.
    of ankle-joint, 154.
        elbow-joint, 145.
        hip-joint, 154.
        knee-joint, 154.
        patella, 154.
        phalanges, 148.
        shoulder-joint, 147.
        tarsal bones, 154.
        vertebræ, 146.
        wrist-joint, 148.
    sterno-clavicular, 146.
    temporo-maxillary, 145.
Dissection, 56.
Disturbance, causes of wound, 23.
    chemical, 23.
    mechanical, 23.
Divulsion in strictures, 690.
Dorsalis pedis artery, ligation of, 311.
    penis artery, ligation of, 321.
Drainage of wounds, 80.
    in aseptic surgery, 24.
    of peritoneum, 464.
    tubes, 80.
        for thorax, 627.
Drains, of wounds, 80.
Duct, obstruction of common, 540.
Duodenostomy, 489.
Duodenotomy, 489.
Duodenum, anatomy of, 488.
    foreign bodies in, 488.
    rupture, 488.

ELASTIC bandage, 39.
        application of, 39.
    rings, 49.
Elbow, dislocation of, 148.
Elbow-joint, anchylosis of, 837.
    excision of, 200.
        subperiosteal, 201.
Electrolysis, in aneurisms, 266.
Elephantiasis arabum, 390.
    of scrotum, 698.
Embolism, 263.
Emergencies, 58.
    air in the veins, 63.
    apnœa, 60.
    asphyxia from blood in the trachea, 61.
    bleeding, 62.
    narcosis, 59.
    shock, 62.
Emphysema, 630.
Encephalocele, 343.
Endermic applications, 399.
Endoscope, 650, 678.
Enterectomy, 502.
Enterorrhaphy, 492.
Enterotomy, 501.
Epididymitis, 701.
Epigastric artery, ligation of, 313.
Epilepsy, 338.
Epispadias, 682.
Epistaxis, 588.
Epithelioma of labia, 481.
    of skin, 391.
    squamous, 391.
Epulis, 429.
Erysipelas, complicating wounds, 106.
Erysipelatous inflammation, 385.
Erythema, 105.
Established rules, conformity to, 19.
Ether, 49.
    administration of, 49.
    apparatus to administer, 49.
    by rectum, 52.
Evacuator, 662.
        Bigelow's, 663.
        Otis's, 664.
Examination of patient, 25.
    physical, 26.
Excision of scrotum in varicocele, 699.
    of joints, 183.
        indications, 183.
    osteoplastic, 217.
        of ankle-joint, 217.
            elbow-joint, 201.
            hip-joint, 225.
            knee-joint, 220.
            metacarpal joints, 192.
            metacarpo-phalangeal, 211.
            metatarso-tarsal joints, 212.
            phalangeal joints, 192–211.
            shoulder-joint, 205.
            tarsal-joints, 212.
            wrist-joint, 193.
    time of, 184.
Exostosis, 157
Extraction of teeth, 431.
Extroversion of bladder, 650.

FACIAL artery, ligation of, 290.
    nerve, anatomy of, 369.
        direction of, 290.
        section, 369.
Fasciæ, contractions of, 246.
    lata, 247.
Fasciatomy, 247.
Feet, distortion of, 823.
Femoral artery, anatomy of, 313.
    ligation of, 313.
        methods, 313.
    wounds of, 260.
Femur, ununited fracture of, 848.
    fracture of, 131, 143.

Femur, fracture of, in children, 134.
    resection of, 224.
    shot-fracture of, 143.
Fever, inflammatory, 108.
    hectic, 108.
    pyæmic, 108.
    septic, 108.
    traumatic, 108.
Fevers complicating wounds, 107.
Fibromata, 442.
Fibula, fracture of, 137.
    compound fracture of, 144.
    resection of, 218.
Fingers, amputation of, 776.
    artificial, 852.
    distortion of, 822.
    paralysis of, 852.
    supernumerary, 822.
    webbed, 822.
Fissure, external parieto-occipital, 350.
    longitudinal, of cerebrum, 348.
        transverse, 348.
    of anus, 529.
        dilatation in, 530.
        Rolando, 349.
        Sylvius, 348.
Fistula in ano, 530.
    intestinal, 502.
    umbilical, 462.
    vaginal, 527.
    vesical, fæcal, 528.
    vesico-vaginal, 742.
Flexion in aneurism, 266.
Foot, artificial, 854.
Forearm, amputation of, 782.
    artificial, 852.
    paralysis of, 849.
Fractures, 120.
    compound, 139.
        malposition after, 831.
        refracture, 831.
    diagnosis of, 121.
    examination, 121.
    gypsum splints, 138.
    of clavicle, 124.
        Colles, 128.
        femur, 131, 143.
        fibula, 137-144.
        humerus, 126.
        inferior maxilla, 122.
        laryngeal cartilages, 601.
        olecranon process, 127.
        ossa-nasi, 122.
        patella, 135.
        radius, 128.
            and ulna, 128.
        ribs and cartilages, 124.
        skull, 332.
        sternum, 124.
Fractures of the spine, 359.
        tibia, 136-144.
            and fibula, 137.
    simple, 121.
    subcutaneous, 121.
    superior maxilla, 141.
Frost-bite, 381.
Furuncles, 385.

GALL-BLADDER. 537.
    cholecystectomy, 540.
    cholecystotomy, 540.
    extirpation of, 540.
    incision of, 539.
    obstruction of, 540.
    operations on, 539.
    rupture, 537.
    stones in, 538.
    wounds of, 538.
Gall-stones, 538.
    cholecystotomy for, 588.
Galvano-cautery, 369.
Ganglia, 242, 243.
Gangrene during repair, 104.
    hospital, 105.
    phagedæna, 104.
    traumatic, 104.
Gastro-enterostomy, 482.
    after-treatment, 481.
    indications for, 478.
    operative methods, 478-481.
Gastrorrhaphy, 475.
Gastrostomy, 478.
Gastrotomy, 478.
Gauze, carbolic, 83.
    iodoform, 83.
General anæsthesia, 48.
Genu valgum and varum, 832, 833.
Gland, prostate, 704.
    thyroid, 621.
Glands, parotid, 483.
    salivary, 433.
        abscesses of, 434.
        calculi of, 434.
        fistulæ of, 435.
        tumors of, 436.
        wounds of, 434.
    sebaceous, 392.
    sub-lingual, 434.
    sub-maxillary, 434.
Glossitis, 440.
Glottis, tubage of, 611.
Gluteal aneurism, 307.
    artery, ligation of, 309.
Goitre, 622.
Grafting, method of, 117.
Granulations, diseased, 115.
    croupous, 115.

Granulations, erethritic, 115.
  exuberant, 117.
  indolent, 116.
Gritti's amputation, 813.
Gunshot wounds, 376.
Gutta-percha, 84.
Gypsum jacket, 174.

HABITS, in prognosis, 28.
Hæmastasis, how secured, 24.
Hæmatoma, 239.
Hæmatomata, 374.
  of testicles, 701.
Hæmorrhoids, 270.
  clamp for, 272.
Hæmo-thorax, 630.
Hair follicles, retained secretions, 392.
  overgrowth of, 392.
Hand, artificial, 852.
  deformities of, 822.
Harelip, double, 413.
  single, 411.
  lower, 415, 416.
Heart, wounds of, 257.
  diseases of, 263.
  extraction of foreign bodies, 258.
  injuries of, 257.
  operations on, 277.
Hectic fever, 110.
Hemorrhage, acupressure in, 44.
  arterial compression in, 40.
  cauterization in, 46.
  constriction in, 46.
  during repair, secondary, 103.
  elastic bandage in, 39.
    compression in, 39.
    rings in, 40.
  from the lungs, 630.
  intermediary, 102.
  intracranial, 334.
  ligation in, 42.
  parenchymatous, 103.
  prevention of, 32.
  subcranial, 335.
  torsion in, 44.
  umbilical, 462.
Hernia, abdominal, 545.
  cerebri, 341.
  contents of, 545.
  crural, 550.
  femoral, 555.
    strangulated, 566.
    treatment, 567.
  inguinal, 546.
    anatomy, 546.
    direct, 555.
    oblique, 547.
    obturator, 577.
Hernia, inguinal, operation for, 557–565.
    radical cure of, 556.
    trusses for, 554.
  sac of, 545.
  strangulated, 566.
  umbilical, 552.
    congenital, 555.
    strangulated, 577.
    treatment, 553.
    truss, 553.
  ventral, 577.
    removal of sac, 565.
Herniotomy, 569.
Hip, splints for, 179.
  dislocations of, 149.
Hip-joint, amputation at the, 813.
    by circular method, 814.
      double flaps, 814.
      single flaps, 815.
    oval, 816.
  anchylosis of, 841.
  caries of, 177.
  excision of, 226, 227.
    after-treatment, 228.
    indications, 225.
    methods of, 226.
History of patient in diagnosis, 26.
Hollow club-foot, 829.
Horn, cutaneous, 385.
Horny growths of nails, 396.
Hospital gangrene, 106.
Hot-water treatment of wounds, 100.
Hour for operations, 33.
Humerus, fracture of, 126, 141.
  resection of, 203.
  shot fracture of, 141.
  ununited fracture of, 846.
Hydatid tumor, 534.
Hydrocele, 699.
Hydrocephalus, 342.
Hydronephrosis, 640.
Hymen, imperforate, 577.
Hypodermic injections, 401.
Hypospadias, 679.
Hysterotome, 727.

ILEUM, anatomy of, 489.
  intussusception of, 496.
  obstruction of, 499.
  shot wounds, 490.
  strangulation of, 499.
  wounds of, 490–494.
Iliac arteries, 308.
  circumflex, 313.
  common, 308.
  external, 312.
  internal, 309.

- Iliac operation, 312.
- Imperforate anus, 525
  - nose, 587.
  - rectum, 517.
  - urethra, 679.
- Incision, how made, 58.
- Incisions in ligation, 281.
- Inferior dental nerve, resection of, 368.
- Inferior maxilla, resection of, 122.
  - fracture of, 122.
  - shot fracture of, 141.
- Inflammations, acute, 107.
- Inflammatory fever, 108.
- Infra-orbital nerves, anatomy, 367.
  - section, intra-buccal, 867.
- Ingrowing nail, 394.
- Inguinal hernia, 546.
- Inhalations, apparatus for, 598.
  - formulæ for, 598.
- Inhaler, 49.
- Injections, hypodermic, 401.
  - arterial, of fluids, 326.
  - in aneurism, 265.
  - into veins, saline, 324.
  - intravenous of milk, 326.
  - rectal, 515.
- Injuries, of arteries, 258.
  - of bladder, 507.
    - bones, 122–123.
    - circulatory system, 257.
    - heart, 257.
    - joints, 166.
    - muscles, 238.
    - nervous system, 361.
    - penis, 710.
    - prostate gland, 704.
    - spine, 357.
    - tegumentary system, 302.
    - thorax, 622.
    - urethra, 533.
- Innominate artery, 284.
  - aneurism of, 284.
  - ligation of, 284.
- Insanity, 338.
  - treatment, 284.
- Instruments, 34.
  - case of, 35.
  - for resection, 184, 185, 186, 187, 188.
  - materials for, 34.
  - preservation of, 35.
  - tests for selection of, for operating, 86.
  - to operate on tongue, 35.
- Insufflators, 586.
  - laryngeal, 598.
- Intercranial hemorrhages, 334.
- Intermediary hemorrhage, 102.
- Internal pudic artery, anatomy, 311.
  - ligation of, 311.
  - cutaneous nerve, 371.
- Intestines, shot wounds of, 494.
  - intussusception, 506.
  - large, wounds of, 490.
  - obstruction, 499.
  - strangulation, 499.
- Intussusception, cæcal, 506.
  - laparotomy in, 467.
  - of jejunum and ileum, 496.
- Iodoform, use of, 82.
  - gauze, 83, 98.
- Issues, 400.

- JAW, anchylosis of lower, 841.
  - tumors of, 433.
- Jejunostomy, 489.
- Jejunum, anatomy, 489.
  - intussusception of, 491.
  - obstruction of, 499.
  - shot wounds, 490.
  - strangulation of, 499.
  - wounds of, 490–494.
- Joints, description of, 120.
  - caries, 169.
    - fungating, 169.
    - simple, 169.
  - diseases of, 166.
  - excision of, 192.
  - inflammation of, 167.
  - injuries of, 166.
  - loose bodies in, 182.
  - operations and injuries of, 166–168.
  - special operations, 166.
  - wounds of, 166.
    - contused, 166.
    - incised, 166.
    - lacerated, 166.
    - punctured, 166.
- Judgment, good, what constitutes, 19.

- KELOTOMY, 569.
- Kidneys, abscess of, 636.
  - anatomy of, 633.
  - calculus of, 639.
  - carcinoma of, 646.
  - cysts of, 638.
  - extirpation of, 502.
  - fistulæ of, 640.
  - floating, 634.
  - misplaced, 634.
  - movable, 634.
  - rupture of, 635.
  - sarcoma of, 646.
  - scrofulous, 637.

Kidneys, tumors of, 638.
    wounds of, 635.
Knee, dislocations of, 154.
Knee-joint, amputation at, 800.
    anchylosis of, 838.
    caries of, 179.
    circular, 810.
    curvatures of, 832.
    dislocation of, 154.
    excision of, 220.
        after-treatment, 223.
        methods, 221, 222.
    osteo-plastic, 809.
Knock-knee, 833.
Knot, in ligation of arteries, 278.
    sailor's, 44.
    surgeon's, 43.
Knowledge required, 18.
Kyphosis, 818.

LACERATION of perineum, 747.
    of rectum, 409.
    of urethra, 683.
    through anal sphincter, 752.
    scrotal, 545.
Laparotomy, 467–471.
    operation, 467.
Laparo-elytrotomy, 730.
Laryngectomy, 609.
Laryngotomy, 602.
Larynx, abscess of, 610.
    anatomy of, 596.
    burns and scalds of, 606.
    bursal tumors of, 612.
    carcinoma, 608.
    dilation of, 604.
    dislocation of cartilages, 601.
    examination of, 597.
    extirpation of, 609.
    foreign bodies in, 602.
    fracture of cartilages, 601.
    growths of, 608.
        malignant, 608.
        non-malignant, 606.
    intubation of, 611.
    medication of, 598.
    obstruction of, 610.
    œdema of, 605.
    sarcoma of, 608.
    stenosis of, 610.
    tubage of, 611.
    wounds of, 600.
        contused, 600.
        incised, 600.
        internal, 601.
        punctured, 600.
Lateral curvature, 818.
    treatment, 819.
Leech, artificial, 327.
Leeching, 327.
    artificial, 327.
Leg, amputation of, 804.
    artificial, 855.
    paralysis of, 850.
Legal construction of obligation, 17.
Ligation, 42.
    of arteries, 278.
        aperture of sheath, 281.
        dissection, 282.
        incision, 281
        instruments, 279.
        ligatures, 279.
            application of, 279.
            aseptic catgut, 280.
            dressing of wound, 283.
        needle passage of, 282.
Ligation in aneurism, 267.
        points of, 279.
    of iliac, 258.
    operation for the, 280.
    rules for head, neck, 284.
        for lower limb, 307.
            upper limb, 295.
Ligatures, in aneurism, 280.
    aseptic catgut, 280.
    catgut, 79.
    silk, 79.
    silkworm-gut, 79.
Limbs, artificial, 855
    dangle, 850
Limited torsion, 44
Lingual nerve, anatomy, 368.
    artery, ligation of, 289.
        resection of, 367.
Lipoma nasi, 393.
Lipomata, 442.
Lips, acquired defects of, 415.
    congenital defects of, 409.
    hypertrophy of, 414.
    reconstruction of, 414–420.
        upper lip and cheek, 417.
            and nose, 419.
                right half, 418.
        angle of lips, 418.
        upper lip, central portion, 420.
    wounds of, 409.
        lower lip, 415, 416.
            and cheek, 417.
                chin, 417.
Lithoclast, 660.
Litholapaxy, 659.
    evacuating apparatus for, 662.
Lithotomy, 667.
    lateral, 667.
    median, 672.
    medio-lateral, 673.
    scoop, 668

Lithotomy staffs, 672, 679.
    supra-pubic, 674.
Lithotrite, Bigelow's, 660.
    introduction of, 662.
    Keyes's, 661.
Lithotrity, dangers of, 660.
    operation of, 664.
    perineal, 675.
    preparative measures, 664.
    rules to be observed, 665.
Liver, abscess of, 535.
    anatomy of, 533.
    cysts of, 535.
    gall-stones in, 538.
    hydatids of, 534.
    rupture of, 533.
    wounds of, 533.
Lobe, frontal, 350.
    occipital, 351.
    parietal, 351.
    temporo-sphenoidal, 351.
Loose bodies in joints, 182.
Lordosis, 817.
Lungs, anatomy of, 624.
    concussion of the, 629.
    hemorrhage from the, 630.
    hernia of the, 630.
    injection of cavities in, 631.
    sarcoma of, 631.
    wounds of the, 629.
        gunshot, 629.
Lymphadenomata, 329.
    obstruction of, 329.
Lymphangitis, after wounds, 106.
Lymphatics, wounds of, 261.
Lymphomata, 329.
Lupus, 388.
    exedens, 388.
    exfoliatus, 388.
    exulcerans, 388
    fungosus, 388.
    hypertrophicus, 388.
    origin, 388.
    symptoms, 388.
    treatment, 389.

MAMMARY artery, ligation of, 293.
    glands, abscess of the, 760.
        extirpation of the, 761.
        inflammation of, 759.
Mastitis, 759.
Material for dressing wounds and their application, 65.
Materials, arrangement of, for operating, 82.
Maxilla inferior, fracture of, 122, 141.
    superior, 140.
Maxillæ, dislocation of, 143.
Meatoscope, 678.
Meatus, contraction of, 689.
    imperforate, 679.
Median lithotomy, 672.
    nerve resection of, 371.
Medication, nasal, 585.
    by œsophagus, 451.
    by the stomach, 472.
    of larynx, 598.
Medio-lateral lithotomy, 673.
Meningocele, 291, 342.
    treatment, 292.
Metacarpal bones, fracture of, 143.
    amputations of, 778.
    resection of, 143.
Metacarpus, shot-fracture of, 143.
Metatarsal bones, amputation in, 792.
    disarticulation of, 792.
    resection of, 211.
Metatarsal joints, excision of, 212.
Milk, intra-venous injection of, 326.
Mouth for operations, 32.
Mouth gag, 422.
Moxas, application of, 331.
Muscles, contractions, 245.
    displacement, 239.
    general operations on, 247.
    hernia of, 239.
    incised wounds of, 240.
    injuries of, 238.
    ruptures of, 238.
Muscular system, diseases of, 238–241.
    bursæ, 240, 241.
    contraction, 245.
        of fascia, 248.
        of tendon, 246.
    inflammation of, 241.
        of tendons, 242.
    tumors of, 244.
Musculo-cutaneous nerve, 370.
Musculo-spiral nerve, 371.
Myositis, 241.
Myotomy, 247.

NÆVUS, cutaneous, 274.
    Nails, atrophy, 394.
        claw-like, 396.
        exostosis, 396.
        horny growths of, 396.
        hypertrophy of, 394.
        inflammation of, 393.
        ingrowing, 394.
        onychia, 395.
        psoriasis of, 396.
Narcosis, 59.
Nasal fossæ, 583.
    exploration of, 583.

- Nasal fossæ, hemorrhage from, 588.
  - medication of, 585.
  - polypi of, 593.
  - rhinoliths, 593.
- Necrosis of bone, 163.
  - partial, 163.
  - pathology of, 164.
  - total, 164.
- Negligence, what constitutes, 19.
- Nephrectomy, 644.
- Nephritic abscess, 636.
- Nephrolithotomy, 643.
- Nephrorraphy, 635.
- Nephrotomy, 642.
- Nerves, compression of, 362.
  - contusion of, 361.
  - inflammation, 363.
  - lesions of, 361.
  - neurectomy, 366.
  - neurotomy, 366.
  - operations on, 365.
  - resection of, 366.
  - section of, 366.
  - stretching of, 362.
  - wounds of, 362.
  - ulceration of, 363.
- Nervous system, anatomy of, 330.
  - affections following wounds, 111.
  - constitution, 365.
  - delirium nervosum, 112.
  - delirium tremens, 111.
  - encephalocele, 343.
  - general operations on, 365.
    - the brain, 344.
    - the nerves, 365.
  - hernia cerebri, 341.
  - hydrocephalus, 342.
  - inflammation of brain, 339.
    - of nerves, 361.
  - injuries of, 333.
    - compression of brain, 333.
      - of nerves, 362.
    - concussion of brain, 333.
      - of spine, 357.
    - contusion of brain, 333.
      - of nerves, 361.
        - skull, 330.
    - fissure of skull, 331.
    - fracture of skull, 331.
      - of spine, 359.
      - treatment of, 332.
    - sprains of spine, 358.
    - wounds of brain, 334–336.
  - meningocele, 342.
  - neuralgia, 364.
  - neuromata, 364.
  - pain, 111.
  - spasms of muscles, 111.
  - spina bifida, 360.
  - subcutaneous tubercles, 363.
  - sutures of, 365.
- Neuralgia, 364.
- Neurectomy, 366.
- Neuritis, 363.
- Neuromata, 364.
- Neuromimesis, 365.
- Neurotomy, 366.
- Nipple, chronic affection of, 760.
- Nitrous oxide, 49.
- Nose, abscess of, 590.
  - cancer of, 494.
  - depression of, 581.
  - foreign bodies in, 590.
  - imperforate, 587.
  - occlusion of, 587.
  - operations on, 578.
  - papillomata of, 590.
  - polypi of the, 590.
  - restoration of entire, 580.
    - of columna, 579.
      - ala, 579.
      - apex, 587.
  - rhinoplasty, 578.
  - sarcomata of, 594.
  - tumors, cartilaginous of, 504.
    - osseous of, 594.
- Nurse, 39.

- OBLIGATION, civil, 17.
  - Obligations, new, 20.
    - legal construction of, 17.
    - professional, 17.
- Obstruction, intestinal, 499.
  - causes, 499.
  - laparatomy in, 500.
  - of common duct, 540.
  - treatment, 500.
- Occipital artery, ligation of, 292.
- Odontomes, 430.
- Œdema of larynx, 605.
- Œsophagotomy, 457.
  - external, 456.
  - internal, 454.
- Œsophagus, anatomy of, 457.
  - foreign bodies in the, 452.
  - medication through the, 451.
  - resection of the, 458.
  - stricture of the, 453.
- Office, operations in, 33.
- Olecranon process, fracture of, 127.
- Onychia, 393.
- Oöphrectomy, 717.
- Operations, antiseptic, 90.
  - age in, 27.
  - bronchitis, chronic, in, 29.
  - cellulitis after, 29.

- Operation, conclusion as to, 31.
  - consent to, 31.
  - constitutional diseases in, 28.
  - decision as to an, 30.
  - details of, 85-92.
  - effect of intemperance on, 28.
    - of overeating on, 28.
  - emphysema, chronic, in, 29.
  - erysipelas, after, 29.
  - external conditions, 30.
  - general preparation for, 31.
  - in acute inflammation, 29.
  - influence of abdominal plethora, 29.
    - affections of heart, 29.
    - anæmia, 28.
    - croup, 29.
    - degeneration of arteries, 29.
    - disease of lungs, 29.
    - diseased veins, 29.
    - dysentery and acute diarrhœa, 309.
    - dyspepsia, 28.
    - enlarged liver, 29.
    - kidney diseases, 29.
    - menstruation and pregnancy, 29.
    - nervous affections, 30.
    - pyæmia, acute, 29.
    - rheumatism and gout, 28.
    - scrofula, 28.
    - shock and loss of blood, 29.
    - strumous affection, 29.
    - syphilis, 28.
  - manual, 55.
  - place for, 33.
    - office, 33.
    - room, 33.
  - preparation of patient, 31.
  - selection of instruments for, 34.
    - care of, necessary, 35.
    - general operating case, 35.
    - materials, 34.
    - preservation of, 35.
    - tests of quality, 35.
  - time for, 32.
    - day, 33.
    - hour, 33.
    - month, 32.
  - when justifiable, 30.
- Operator, preparation of, 76, 87.
- Orchitis, syphilitic, 722.
- Os calcis, resection of, 214.
- Ossa nasi, fracture of, 122.
- Osteoclasis, 237.
- Osteoclast, 831.
- Osteo-myelitis, 161.
- Osteoplasty, 237.
- Osteotomy, 237, 831.
- Ovarian cyst, 717.
  - inflammation, 716.
  - trocars, 719.
- Ovaries, anatomy of, 716.
  - cystic tumors of, 717.
  - inflammation of, 716.
  - removal of, 717.
  - tapping the, 718.
- Ovariotomy, 719.
  - abdominal, 720.
  - clamp, 564.
  - trocars, 722.
  - vaginal, 719.
- Ovaritis, 716.
  - operative treatment, 717.

- PACHYDERMATOCELE, molluscum, fibrosum, 391.
- Pain in wounds, 111.
- Palate, 421.
  - cleft, 422.
  - congenital defects, 421.
  - operations on the, 422.
    - instruments for, 421.
  - soft, contraction of, 427.
- Pancreas, 540.
  - cysts of, 540.
  - rupture of, 540.
  - wounds of, 540.
- Papillomata, nasal, 590.
  - of tongue, 442.
- Paracentesis abdominis, 463.
  - of pericardium, 277.
  - thoracis, 626.
    - indications for, 626.
    - instruments for, 626.
    - methods, 627.
    - mortality, 277.
- Paralysis, appliances for, 848.
- Paraphimosis, 712.
- Parenchymatous hemorrhage, 103.
- Parotid gland, anatomy, 433.
  - abscess of the, 434.
  - calculi of the, 433.
  - extirpation of the, 433.
  - fistulæ of the, 435.
  - tumors of the, 436.
  - wounds of the, 434.
- Patella, fracture of, 135.
  - dislocation of, 154.
  - non-united fracture of, 847.
  - resection of, 224.
- Patient, arrangement of, on table, 89.
  - history of, in diagnosis, 26.
  - preparation of, 31, 76.
- Penis, amputation of, 715.
  - cancer of the, 714.
  - circumference of, 678.

- Penis, extirpation of, 715.
  - injuries of the, 710.
  - warts of, 714.
- Pericardium, paracentesis of, 277.
- Perineal lithotrity, 675.
  - nerve, resection of, 372.
- Perineorraphy, 748.
- Perinephritic abscess, 637.
- Perineum, laceration of, 747.
  - operative methods, 748.
- Periostitis, 160.
- Peritoneal abscesses, 466.
- Peritoneum, 462.
  - aspirations of, 463.
  - cavity of, 463.
- itonitis, 465.
  - treatment of, 465.
- Peroneal artery, ligation of, 321.
  - nerve, resection of, 372.
- gedæna in repair of wounds, 104.
- langeal bones, fracture of, 143.
  - joints, anchylosis of, 837.
    - excision of, 192–211.
- Phalanges, amputation of, 790.
  - dislocation of, 148.
  - distortion of, 822.
  - resection of, 192.
  - supernumerary, 822.
  - webbed, 822.
- Pharyngeal abscess, 450.
- Pharynx, abscess of, 450.
  - foreign bodies in, 450.
  - inspection of, 449.
  - wounds of, 449.
- Phimosis, 711.
  - operation for, 711.
- Physical examination in diagnosis, 26.
- Pirogoff's amputation, 802.
- Place for operations, 33.
- Plantar nerve, internal, 373.
- Plastic apparatus, 73.
  - gypsum splint, 74.
  - silica bandage, 75.
  - starch bandage, 74.
- Pleura, wound of, 625.
  - collection of pus in, 632.
- Pneumocele, 630.
- Pneumotomy, 632.
- Poisoned wounds, 380.
- Polypi of the tongue, 441.
  - nasal, 592.
- Polypus forceps, 591.
  - snare, 592.
- Popliteal artery, 264.
  - aneurism of, 301.
    - ligation of, 316.
  - nerve, resection of, 372.
    - operations, 316, 317.
- Preparation of patient, 31.
  - for the operation, 188.
- Preservation of instruments, 35.
- Principles of an art, 17.
  - antiseptic surgery, 22.
- Prognosis, age in, 27.
  - constitutional diseases in, 28.
  - deranged conditions of organs, 28.
  - habits and temperaments in, 28.
  - nativity in, 27
  - other affections in, 29.
  - sex in, 27.
- Progress of disease in diagnosis, 26.
  - of repair, 100.
- Prolapse of rectum, 520.
- Prostate gland, 704.
  - catheterism in, 706.
  - hypertrophy of, 705.
  - inflammation of, 704.
  - injuries of the, 704.
- Prostatectomy, 709.
- Prostatic catheters, 708.
  - guide, 708.
- Prostatitis, acute, 704.
- Prostatotomy, 709.
- Pseudarthrosis, 845.
  - drill in, 845.
  - resection in, 651.
  - section, subcutaneous, in, 845.
- Psoriasis of nails, 396.
- Pyæmia, causes, 109.
- Pylorectomy, 484.
- Pylorus, 483.
  - dilatation of, 483.
  - excision of, 484.
  - operation, 484–487.

- QUALIFICATIONS of surgeon, 18.
  - knowledge, degree of, 18.
  - limit to, 18.
  - lowest grade of, 18.

- RADIAL artery, wounds of, 260.
    - ligation of, 300.
  - nerves, resection of, 372.
  - operation, 301.
- Radius, fracture of, 128, 141.
  - and ulna, fracture of, 128, 141.
  - and ulna, resection of, 128.
  - non-united fracture of, 846.
  - resection of, 196, 199.
  - shot fracture of, 141.
- Ranula, treatment of, 434.
- Reconstruction of lips, 414–420.
- Rectotomy, 519.
- Rectum, abscess near, 518.

Rectum, absence of, 517.
  alimentation by, 516.
  anatomy of the, 514.
  cancer of the, 522.
  exploration of the, 515.
  extirpation of, 523.
    with prostate and base of the bladder, 524.
    by ether, 52.
  foreign bodies in, 522.
  hemorrhoids, 522.
  imperforate, 517.
  laceration of, 517.
  medication by, 515.
  polypus of the, 521.
  prolapse of the, 520.
  speculæ for, 515.
  stricture of, 518.
Refracture of bones, 831.
Renal abscess, 636.
  calculi, 636.
Repair of wounds, 100.
  complications of, 105.
  fevers during, 101–107.
  gangrene during, 104.
  hemorrhage during, 102.
  indications of, 101.
  inflammations in, 105.
  nervous affections in, 111.
  normal, 102.
  pulse in, 101.
  wound changes in, 101.
Resection, 183.
  indications, 183.
  instruments, 184–188.
  of bones, 183.
  of nerves, 366.
    brachial plexus, 369, 370.
    cutaneous, internal, 371.
    dental inferior, 368.
    digital, 372.
    lingual, 368.
    median, 371.
    musculo-cutaneous, 370.
    musculo-spiral, 371.
    perineal, 372.
    peroneal, 372.
    plantar, internal, 373.
    popliteal, 372.
    radial, 372.
    saphenous, external, 373.
      internal, 373.
    sciatic, great, 372.
      small, 372.
    supra-maxillary, 367.
      orbital, 367.
    supra-orbital, 367.
      infra-orbital, 367.
    tibial anterior, 373.
Resection of tibial, posterior, 373.
    treatment of resection wounds, 190.
  of œsophagus, 458.
  operation, 189.
    astragalus, 213.
    clavicle, 209.
    coccyx, 230.
    cuboid, 213.
    cuneiform, 212.
    femur, 224.
    fibula, 218.
    humerus, 203.
    inferior maxilla, 230–234.
    metacarpal bones, 190, 211.
    metatarsal bones, 21.
    methods, 232, 233.
    os calcis, 214.
    patella, 224.
    phalanges of fingers, 190.
      of toes, 211.
    radius, 196, 199.
      and ulna, 197.
    ribs, 230.
    sacrum, 229.
    scaphoid, 213.
    scapula, 207.
    superior maxilla, 234–237.
    tarsal, 214.
    tibia, 219.
    ulna, 197–199.
    vertebra, 229.
  preparation for operation, 188.
  time for, 184.
  treatment for wounds, 190.
Respiration, artificial, 60.
  rapid, 52.
Responsibility in operation, 19.
Restoration of entire nose, 580.
Resuscitation in narcosis, 59.
Retention of urine, 694.
Retro-pharyngeal abscess, 450.
Retroversion of uterus, 728.
Rhinoplasty, 578.
Rhinoscope, 584.
Rhinoscopy, 583.
  instruments for, 583.
Ribs and cartilages, fracture of, 124.
  resection of, 230.
Rickets, treatment of, 156.
Rings, elastic, 40.
  isolating, 55.
Rodent ulcer, 389.
Room for convalescent, 38.
  for antiseptic operations, 86.
    operating, 33.
Rubefacients, 398.
Rupture of arteries, 258.
  of bladder, 537.

Rupture of kidney, 635.
    muscles, 238.
    small intestines, 489.
    spleen, 543.
    tendons, 238.

SACRUM, resection of, 229.
Salicylic acid cream, use of, 82.
Saphenous nerve, external, 373.
  internal, resection of, 373.
Saw, chain, 185.
Scalds, 382
    cicatricial contractions in, 406.
    degrees of, 382.
Scaphoid bone, resection of, 213.
Scapula, resection of, 207.
Scarification, 327.
Sciatic artery, ligation of, 310.
    nerve, great, 372.
      resection of, 372.
    nerve, small, resection of, 372.
Scoliosis, 817.
Scrotum, cancer of, 698.
    contusions of, 697.
    elephantiasis of the, 698.
    inflammation of the, 697.
    laceration of the, 697.
    mortification of the, 698.
Section, Cæsarean, 730.
Septic fever, 108.
    inflammation in wounds, 106.
Sequestrotomy, 165.
Setons, application of, 400.
Sex in prognosis, 26.
Shock, 62.
Shot fractures, 139.
    of clavicle, 141.
      femur, 143.
      humerus, 141.
      inferior maxilla, 141.
      metacarpal bones, 143.
      phalangeal bones, 143.
      radius and ulna, 141.
      superior maxilla, 141.
      tibia and fibula, 144.
Shoulder, dislocation of, 147.
      reduction of, 147.
    excision of, 205.
      indications, 206.
      subperiosteal, 207.
Shoulder-joint, anchylosis of, 838.
    amputation at, 786.
      by double flap, 789.
        oval method, 787.
        modified, 788.
        single flap, 784.
Silica bandage, 75.
Silk ligature, 79.
Sinuses, granulating, 94.
Skill, implied, 18.
Skin, contusion of, 330.
    diseases of, 384.
    hæmatoma of, 374.
    injuries of, 374.
    operations on, 397.
    transplantation of, 405.
    tumors of, 330.
Skull, diseases of, 832.
    fissures of, 331.
    fractures of, 331.
    trephining, 344.
Solutions, antiseptic, 77–87.
    irrigating, 87.
Sound, tunnelled, 692.
Specula, vaginal, 740.
    nasal, 583.
    rectal, 515.
Spermatic cord, hæmatocele of, 700.
    hydrocele of, 701.
Spina bifida, 360.
Spinal abscess, 176.
    caries, 171.
      apparatus for, 173, 174, 175, 176.
    column, 817.
Spine, anterior curvature, 817.
    caries of, 171.
    concussion of, 357.
    fractures of, 359.
    growths, 361.
    lateral curvature, 818.
    posterior curvature, 888.
    railway injuries of, 357.
    sprains of, 358.
Spleen, anatomy of, 543.
    extirpation, 544.
    hypertrophy of, 544.
    incision, 544.
    rupture of, 543.
    wounds of, 543.
Splenotomy, 544.
Sponges, use of, 79, 87.
Sprains of spine, 358.
Staff, lithotomy, 668.
Staphylorraphy, 422.
    knife, 422.
    operative methods, 422.
    sutures in, 422.
Starch bandage, 74.
Sterno-clavicular dislocation, 146.
Sternum fracture, 124.
    resection of, 230.
Stomach, anatomy of, 471.
    alimentation by fistula of, 481.
    dilation, 476.
    excision of portions of, 482.

- Stomach, foreign bodies in, 475.
  - medication by, 472.
  - pumps, 472.
  - tube, 473.
  - wound of the, 474.
- Strangulation of intestines, 499.
- Strapping testicle, 701.
- Stricture of œsophagus, 453.
  - dilatation of, 453–454.
  - of cardiac orifice, 471.
  - of the urethra, 686.
    - dilatation of, 690.
    - division of, 692.
    - divulsion of, 690.
    - large calibre, 689.
    - location of, 686.
    - permanent, 686.
    - small, 692.
    - spasmodic, 686.
    - symptoms, 686.
    - treatment of, 688.
    - varieties of, 686.
  - rectal, 518.
- Subclavian artery, anatomy, 295.
  - aneurism of, 295.
  - ligation of, 295.
- Sublingual gland, 434.
- Submaxillary gland, 434.
- Superior maxilla, resection of, 234.
  - shot fracture of, 140.
- Superior maxillary nerve, 367.
  - resection of, 368.
  - section of, 368.
- Supra-orbital nerve, anatomy, 367.
  - resection, 367.
  - section, 367.
- Supra-pubic lithotomy, 674.
- Suppuration, causes of, 23.
  - putrefactive, 23.
- Surgery, basis of aseptic, 24.
  - principles of antiseptic, 22.
    - application of, 76.
- Suspension apparatus, 173.
- Suture, button, 69.
  - interrupted, 66.
  - materials for, 60.
  - metallic, 79.
  - needles for, 57.
  - quilled, 69.
  - twisted, 68.
- Syme's amputation, 800.
- Syncope, symptoms, treatment, 61.
- Synovitis, chronic, 167
  - parenchymatous, 167.
  - purulent, 167.
  - serous, 167.
- Syringe, laryngeal, 587.
- Syringes, rectal, 516.
- TABLE, gynæcological, 741.
  - preparation for operating, 88.
- Talipes calcaneus, 826.
  - equinus, 825.
  - valgus, 827.
  - varus, 827.
- Tampon-canula, laryngeal, 609.
- Tapping in ascites, 464.
  - the ovary, 718.
- Tarsal bones, dislocations of, 154.
  - resection of, 212.
- Tarsal joints, excision of, 214.
- Tarso-metatarsal disarticulation, 795.
- Tarsus, disarticulation of, 798.
- Taxis, 568.
- Teeth, extraction of, 431.
- Tegumentary system, 374, 408.
  - acupuncture, 480.
  - applications, endermic, 399.
  - diseases of, 384.
    - acne rosacea, 392.
    - callosity, 384.
    - carbuncle, 386.
    - cellulitis, 387.
    - corn, 385.
    - cutaneous horn, 385.
    - elephantiasis, 390.
    - epithelioma, 391.
    - erysipelatous inflammation, 385.
    - fibrous tumor, soft, 391.
    - furuncle, 385.
    - hair, overgrowth, 392.
    - lupus, 388.
    - nail, atrophy of, 393, 394.
      - claw, 396
- Tegumentary system, diseases of, 393–396.
  - nail, hypertrophy of, 394.
    - horny growths, 396.
    - inflammation, 387, 393.
    - ingrowing, 393.
    - onychia, 393.
    - psoriasis, 396.
    - retained secretions, 392.
    - rodent ulcer, 389.
    - sarcomata of, 391.
    - ulcer of, 388.
    - warts of, 385.
  - general operations on the, 397.
  - injections, hypodermic, 400.
  - injuries of, 374.
    - burns, 382.
    - chilblains, 381.
    - contusion, 374.
    - frostbite, 381.
    - scalds, 382.
    - wounds, contused, 376.
      - incised, 375.

- Tegumentary system, injuries of, gunshot, 376.
    - lacerated, 376.
    - poisoned, 380.
  - issues in, 400.
  - operations on, 374–384.
  - rubefacients, 398.
  - thermometry, 397.
  - transplantation of skin, 405.
  - vaccination, 403.
  - vesicants, 399.
- Telangiectasis, 275.
- Temporal artery, ligation of, 291.
- Temporo-maxillary dislocation, 145.
- Tenaculum forceps, 42.
- Tendo Achillis, division of, 253.
- Tendons, contraction of, 246.
  - inflammations of, 242.
  - rupture of, 238.
    - of biceps flexor cubiti, 240.
      - quadriceps extensor, 240.
      - tendo Achillis, 240.
      - triceps extensor cubiti, 240.
    - wounds of, 240.
- Tenotomes, 248.
- Tenotomy, 247.
  - after-treatment of, 249.
  - indications for, 248.
  - instruments for, 248.
  - of adductor longus, 255.
    - biceps flexor cruris, 254.
      - cubita, 251.
    - deltoid, 251.
    - extensor longus digitorum, 252.
      - proprius pollicis, 252.
    - extensors of fingers, 250.
    - flexor carpi radialis, 250.
      - ulnaris, 251.
    - flexors of fingers, 250.
    - gracilis, 254.
    - latissimus dorsi, 251–256.
    - longissimus dorsi, 255.
    - longus digitorum, 252.
      - pollicis, 250, 252.
    - multifidus spinæ, 255.
    - palmaris longus, 251.
    - pectineus, 254.
    - pectoralis major, 251.
    - peroneus brevis, 253.
      - longus, 253.
      - tertius, 253.
    - quadriceps extensor, 254.
    - sacro-lumbalis, 255.
    - sartorius, 254, 255.
    - semi-membranosus, 254.
    - semi-tendinosus, 254.
    - sterno-cleido-mastoid, 256.
    - tendo Achillis, 253.
    - tensor vaginæ femoris, 255.
- Tenotomy of teres major, 251.
    - thumb, 250.
    - tibialis anticus, 252.
      - posticus, 253.
    - trapezius, 256.
    - triceps extensor cubiti, 251.
  - operation of, 249.
- Testicles, 697, 701.
  - cancer of the, 703.
  - epididymitis, 701.
  - extirpation of, 703.
  - hæmatocele of, 701.
  - orchitis, syphilitic, 702.
  - sarcoma of, 703.
  - strapping of, 701.
  - tubercles of, 703.
- Tests for instruments, 35.
- Tetanus, symptoms, treatment, 112.
- Thermo-cautery, 47.
- Thermometers, 397.
  - uses of, 397.
- Thermometry, 397.
- Thermoscope, 398.
- Thigh, amputation at, 811.
  - artificial, 855.
  - by antero-posterior flaps, 812.
  - by lateral flaps, 812.
  - paralysis of, 849.
- Thoracoplasty, 629.
- Thorax, arteries of, 284.
  - foreign bodies in, 626.
  - injuries of the, 625.
  - tapping the, 626.
  - thread, ligature, 79–86.
- Thrombosis, arterial, 263.
  - venous, 268.
- Thrombus of labia, 747.
- Thumb, amputation of, 777.
- Thyroid gland, anatomy of, 621.
  - arteries, ligation of, 294.
    - inferior, 294.
    - superior, 289.
  - excision of, 623.
  - tumors of, 623.
  - wounds of, 622.
- Thyrotomy, 603.
- Tibia, amputation of, 804.
  - curvature, 835.
  - fracture of, 136, 144.
  - non-united fracture of, 846.
  - resection of, 219.
- Tibia and fibula, fracture of, 137.
  - shot-fracture of, 144.
- Tibial arteries, wounds of, 260.
  - artery, anterior, ligation of, 319.
    - posterior, ligation of, 317.
  - nerves, resection of, 373.
- Time for operations, 32.
- Toes, amputations of, 790.

- Toes, artificial, 854.
  - contraction of, 830.
  - disarticulations of, 790.
  - distortions of, 830.
  - hypertrophy of, 830.
- Tongue, abscess of, 441.
  - angeioma of, 442
  - cancer of, 443.
  - excision, 443.
    - of tip, 443.
      - anterior half, 444.
      - entire, 446.
      - half, 448.
      - part of each jaw, 448.
      - submaxillary glands, 448.
      - side of pharynx, 448.
    - after-treatment, 449.
  - fibromata of, 442.
  - hypertrophy of, 441.
  - instruments to operate on, 368.
  - lymphomata of, 442.
  - œdema of, 370.
  - papillomata of, 442.
  - polypi of, 441.
  - tie, treatment of, 440.
  - wounds of, 440.
- Tonsillotome, 438.
- Tonsils, anatomy of, 437.
  - abscess of the, 437.
  - cancer of the, 438.
  - excision of the, 438.
  - hypertrophy of the, 438.
  - instruments to operate on the, 437.
  - scissors, 438.
- Tooth tumors, classification, 430.
- Topography, cranio-cerebral, 347–353.
- Torsion, 44.
  - free, 44.
  - limited, 44.
- Tourniquet, 41.
- Towels, use of, in an operation, 87.
- Trachea, anatomy of, 612.
  - exploration of the, 612.
  - growths in, 613
  - obstruction of the, 613.
  - wounds of, 612.
- Tracheal canulæ, 616.
  - double hooks, 617.
  - forceps, 617.
  - trocars, 617.
- Tracheotomes, 614.
- Tracheotomy, 613.
  - instruments for, 614.
  - operative methods, 614.
    - in cramp, 617.
- Transfusion, indications, 323.
  - methods, 323–326.
- Transplantation of skin, 405.
- Traumatic gangrene, 104.
  - fever, 108.
- Trephining, 355.
  - contra-indications, 352, 353.
  - indications, 352.
  - instruments for, 355.
  - the cranium, 344.
  - the spine, 293.
- Tripier's amputation, 798.
- Trocar, abdominal, 463.
  - ovarian, 719.
- Trusses for herniæ, 553.
- Tubage of larynx, 611.
- Tube, drainage, 80.
  - bone, 80.
  - rubber, 80.
- Tubercles of testis, 703.
  - painful subcutaneous, 363.
- Tumors of bone, 156.
  - bursal, 612.
  - carcinomata, 160.
  - chondromata, 157.
  - exostoses, 157.
  - fibromata, 159.
  - rules for treatment, 157.
  - sarcomata, 158.

- ULCER, 388.
  - callous, 388.
  - erethritic, 388.
  - fungous, 388.
  - treatment, 388.
- Ulna, resection of, 197.
  - non-united fracture of, 128.
  - ununited, 846.
- Ulnar artery, ligation of, 304.
  - artery, wounds of, 260.
  - nerve, resection of, 372.
- Umbilicus, hemorrhage of, 462.
  - abscess of, 462.
  - fistula of, 462.
  - hernia of, 462.
  - morbid growths of, 462.
- Ungual exostosis, 396.
- Union, by first intention, in aseptic surgery, 24
- Uranoplasty, 425.
  - age for operating, 425.
  - conditions for success, 425.
  - operation of, 425.
  - preparatory treatment, 425.
- Ureter, 646.
  - exploration of, 647.
  - occlusion of, 647.
  - wound of, 647.
- Urethra, anatomy of, 677.
  - calculus in, 684.
  - calibre of, 677.

Urethra, caruncle, 696.
  exploration of, 678.
  female, 695.
  foreign bodies in, 684.
  imperforate, 679.
  laceration of the, 683.
  measurement of, 677.
  prolapsus in women, 696.
  stricture of the, 636, 696.
  tapping the, 695.
  wound, 683.
Urethra-meter, 678.
Urethral calculus, 684.
  calibre, 677.
  catheterism, 649.
  exploration, 677.
  forceps, 684.
  scoop, 685.
  trilabe, 685.
  veins, varicose, 272.
Urethroplasty, 689.
Urethrotomes, 692, 693.
Urethrotomy, external, 693.
  in female, 696.
  internal, 692.
Urine, retention of, 694.
Uterine cancer, 735.
  exploration, 727.
  fibroids, 729.
Uterine polypi, 728.
  sounds, 727.
Uterus, anatomy of, 726.
  cancer of, 735.
  cervical constriction of, 727.
  exploration of cavity, 727.
  fibrous tumors of the, 729.
  polypus of the, 728.
  retroversion of the, 728.
Uvula, abscess of, 428.
  elongation of, 428.
  instruments for operating on, 428.
    forceps, 428.
  tumors, 428.
Uvulatome, 357.

VACCINATION, 403.
  Vagina, exploration of, 740.
    tumors of the, 746.
Vaginal fistula, 742.
  operative methods, 743.
  specula, 740.
Vaginismus, 745.
Varices, 269.
Varicocele, 272.
Varicose veins, 269.
  aneurism, 269.
Veins, air in the, 63.
  contusion of, 260.
Veins, hemorrhoidal, 276.
  internal saphena, 269.
  spermatic, 272.
  thrombosis, 268.
  urethral, 278.
  varicose, 261.
    of spermatic cord, 272.
    urethra, 272.
  venous nævi, 274.
  wounds of, 261.
Venesection, 322.
Venous nævi, 274.
  thrombosis, 268.
Vermiform appendix, abscess of, 504.
  perforation of, 504.
Verrucæ, 385.
Vertebræ, articulation of, 146.
  caries of, 123, 171.
  dislocation of, 146.
  fracture of, 123.
  resection of, 229.
Vertebral artery, ligation of, 293.
  wounds of, 259.
Vesical fæcal fistula, 528.
  calculi, 658.
    in women, 676
  catheters, 646.
  exploration, 648.
  extroversion, 651.
  inflammation, 653.
  irrigator, 654.
  sounds, 650.
  wounds, 653.
Vesicants, 399.
Vesico-vaginal fistula, 742.
  operation for, 743.
Vulva, epithelioma of, 747.
  laceration of, 747.

WARD for convalescents, 38.
  Warts, treatment of, 385.
Women, calculus in, 676.
Wounds, abnormal, changes in, 22.
  cavernous, 94.
  cicatrization of, 114.
  deep, 94.
  disinfection of, 24.
  disturbances of, 23.
  drainage of, 80.
  dressing, antiseptic, 92.
    closed, 92.
    external, 83.
    immediate, 81.
    opened, 93, 98.
  fever in, 107.
  gangrene, 104.
  gunshot, 376.
  hot-water treatment, 100.

Wounds, incised, 315.
  infected, 94.
  inflammation of, 105.
  lacerated, 376.
  materials for dressing, 65.
  mouth, 95.
  muscles, 240.
  nervous affections complicating, 111.
  normal changes in, 22.
  of abdominal walls, 459.
    arteries, 259.
    brain, 236.
      shot-wounds, 386.
        operation, 337.
Wounds of neck, 259.
  pharynx, 448.
  poisoned, 380.
  rectum, 96.
  repair of, 100.
  tendons, 241.
  urethra, 86.
  vagina, 96.
  veins, 260.
Wrist, excision of, 193.
    after-treatment, 194.
  dislocation of, 148.
  joint, anchylosis of, 837.
  paralysis of, 849.

LEA BROTHERS & CO.'S

(*Late HENRY C. LEA'S SON & CO.*)

CLASSIFIED CATALOGUE

OF

MEDICAL AND SURGICAL

PUBLICATIONS.

In asking the attention of the profession to the works advertised in the following pages, the publishers would state that no pains are spared to secure a continuance of the confidence earned for the publications of the house by their careful selection and accuracy and finish of execution.

The large number of inquiries received from the profession for a finer class of bindings than is usually placed on medical books has induced us to put certain of our standard publications in half Russia; and, that the growing taste may be encouraged, the prices have been fixed at so small an advance over the cost of sheep as to place it within the means of all to possess a library that shall have attractions as well for the eye as for the mind of the reading practitioner.

The printed prices are those at which books can generally be supplied by booksellers throughout the United States, who can readily procure for their customers any works not kept in stock. Where access to bookstores is not convenient books will be sent by mail postpaid on receipt of the price, and as the limit of mailable weight has been removed, no difficulty will be experienced in obtaining through the post-office any work in this catalogue. No risks, however, are assumed either on the money or on the books, and no publications but our own are supplied, so that gentlemen will in most cases find it more convenient to deal with the nearest bookseller.

LEA BROTHERS & CO.

Nos. 706 and 708 SANSOM ST., PHILADELPHIA, May, 1887.

PROSPECTUS FOR 1887.

The American Journal of the Medical Sciences.

Quarterly, 300–350 *pages, with illustrations.* *Price*, $5.00 *per annum.*

With the year 1886 THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES became in Great Britain the recognized organ of the profession—a position similar to that occupied by it in America for sixty-six years. On its announcement, this project for an international journal was welcomed abroad with acclamation, and one hundred and thirty-five of the foremost English practitioners authorized the use of their names as contributors in order to aid in extending over their country the benefits which American medicine has enjoyed from the existence of THE JOURNAL during two generations. This friendly challenge was accepted by an almost equal number of Americans, to whose proved ability this country can well afford to entrust her reputation.

In thus becoming the medium of communication between the two nations distinguished above all others by the practical character of their labors, THE JOURNAL undoubtedly forms the most efficient factor in medical progress which the world has yet seen. Already this generous spirit of rivalry has proved that the ample space devoted to *Original Articles* will continue to be filled with a series of contributions unapproachable in value.

THE AMERICAN JOURNAL of the MEDICAL SCIENCES.

(Continued from first page.)

But it is not only in the *Original Department* that the Journal of the future will seek to eclipse all its efforts in the past. The mass of contributions to medical literature and science increases with such rapidity, that if the reader is to keep abreast with them the matter must be carefully sifted, and arranged so as to enable him to grasp it understandingly with the least possible expenditure of time. In the *Bibliographical Department*, therefore, separate reviews are devoted only to works of exceptional importance. As a rule, new books are considered in groups of cognate subjects, the reviewer setting forth tersely the merits of the individual volumes with a condensed statement of the views of the authors. In this manner the reader is kept advised of the products of the press in the most convenient manner.

A similar plan is adopted in the *Quarterly Summary of Progress*. The various branches of medical science have been assigned to the following gentlemen, who will furnish well-digested *résumés* of progress, paying special attention to clinical application: Anatomy, George D. Thane, M. R. C. S.; Physiology, Gerald F. Yeo, M. D.; Materia Medica, Therapeutics and Pharmacology, Roberts Bartholow, M. D., LL. D.; Medicine, William Osler, M. D.; Surgery, in America, R. J. Hall, M. D.; in Europe, Frederick Treves, F. R. C. S.; Ophthalmology, L. Webster Fox, M. D.; Otology, Charles H. Burnett, M. D.; Laryngology, J. Solis Cohen, M. D.; Dermatology, Louis A. Duhring, M. D., and H. W. Stelwagon, M. D.; Midwifery and Gynæcology, D. Berry Hart, M. D.; Jurisprudence, Matthew Hay, M. D.; Public Health, Shirley F. Murphy, M. R. C. S.

The publishers feel an honest pride in thus being the means of bringing together the professions of the two great English speaking peoples, and in laying before them a periodical which must be universally recognized as marking a new era in medical progress. Believing that it will be regarded as indispensable by all intelligent physicians on both sides of the Atlantic, they feel themselves warranted, by the expectation of a large increase in circulation, in maintaining the present very moderate subscription price, notwithstanding the greatly augmented expenditure entailed by the change.

The Journal will continue to be published quarterly, as heretofore, on the first of January, April, July and October.

Price, FIVE DOLLARS Per Annum, in Advance.

THE MEDICAL NEWS.

A National Weekly Periodical, containing 28 to 32 Quarto Pages in Each Issue.

The continually increasing appreciation of The Medical News by the profession throughout the country, is a most gratifying recognition of the policy pursued by the managers of this journal in their unceasing efforts to enhance its value to the practitioner.

Possessing a most efficient organization The News unites the best features of the medical magazine and newspaper. Its large and able Editorial Staff discusses in each issue the important topics of the day in a thoughtful and scholarly manner, while its corps of qualified reporters and correspondents, covering every medical centre, insures that its readers shall be promptly and thoroughly posted upon all matters of interest in the world of medicine. On account of the position conceded to The News, it has become the medium chosen by the leading minds of the profession for the publication of their most important contributions to medical science. The valuable instruction afforded in Clinical Lectures, and the rich experience gained in the leading Hospitals of the world are constantly laid before the readers of The News, while prompt and authentic reports of Society Proceedings are received from special reporters in various sections of the country by mail and Telegraph. In the pages devoted to the progress of Medical Science are found early notes of all important advances, gleaned from the principal journals of both hemispheres. Ample space is devoted to Reviews, News Items, Correspondence and Notes and Queries In short, every branch of medicine is adequately represented in The News, and the details of plan and typography have been carefully studied in order to economize the time and secure the comfort of the reader in every possible way.

Price, FIVE DOLLARS Per Annum, in Advance.

COMMUTATION RATE.

To subscribers paying in advance for 1887:—

American Journal of the Medical Sciences (quarterly) } To one address for $9.00
The Medical News (weekly) } per annum.

SPECIAL OFFERS.

Advance-paying subscribers to either or both of the above-named periodicals may take advantage of any one of the following offers:

(1). The Medical News Visiting List for 1887, *dated*, either for 30 patients per week (1 vol.), or for 60 patients (2 vols.), or for 90 patients (3 vols.), will be sent post-paid on receipt of 75 cents per volume (regular price $1.25). (2). THE YEAR-BOOK OF TREATMENT for 1886 will be sent on receipt of 75 cents (regular price $1.25). (3). An *advance* remittance of $10 will procure THE NEWS and THE JOURNAL for one year, together with any one volume of THE MEDICAL NEWS VISITING LIST and THE YEAR-BOOK OF TREATMENT for 1886, as offered above. Subsequent volumes of THE MEDICAL NEWS VISITING LIST may be procured by *advance*-paying subscribers for 75 cents each (regular price $1.25). Thumb-letter Index for quick use, 25 cents additional.

Subscribers can obtain, at the close of each volume, cloth covers for THE JOURNAL *(one annually), and for* THE NEWS *(one annually), free by mail, by remitting Ten Cents for the* JOURNAL *cover, and Fifteen Cents for the* NEWS *cover.*

☞ The safest mode of remittance is by bank check or postal money order, drawn to the order of the undersigned; where these are not accessible, remittances for subscriptions may be sent at the risk of the publishers by forwarding in *registered* letters. Address,

LEA BROTHERS & CO., 706 and 708 Sansom Street, PHILADELPHIA.

THE MEDICAL NEWS VISITING LIST FOR 1887.

Containing Calendar for two years. Obstetric diagrams. Scheme of Dentition. Tables of weights and measures and comparative scales. Instructions for examining the urine. List of disinfectants. Table of eruptive fevers. Lists of new remedies and remedies not generally used, Incompatibles, Poisons and Antidotes. Artificial respiration. Table of doses, prepared to accord with the last revision of the U. S. Pharmacopœia, an extended table of Diseases and their remedies, and directions for Ligation of Arteries. Blanks for all records of practice and Erasable tablet. Handsomely bound in limp Morocco, with tuck, pencil, rubber and catheter scale.

In response to numerous requests, THE MEDICAL NEWS VISITING LIST for 1887 is issued in three sizes, viz.: Dated, for 30 patients per week, 1 vol.; dated, for 60 patients, 2 vols.; dated, for 90 patients, 3 vols.; Price per volume, $1.25. Also, furnished with Ready Reference Thumb-letter Index for quick use, 25 cents additional. For special offers, including VISITING LIST, see above.

THE MEDICAL NEWS PHYSICIANS' LEDGER.

Containing 400 pages of fine linen "ledger" paper, ruled so that all the accounts of a large practice may be conveniently kept in it, either by single or double entry, for a long period. Strongly bound in leather, with cloth sides, and with a patent flexible back, which permits it to lie perfectly flat when opened at any place. Price, $5.00. Also, a small special lot of same Ledger, with 300 pages. Price, $4.00.

HARTSHORNE, HENRY, A. M., M. D., LL. D.,

Lately Professor of Hygiene in the University of Pennsylvania.

A Conspectus of the Medical Sciences; Containing Handbooks on Anatomy, Physiology, Chemistry, Materia Medica, Practice of Medicine, Surgery and Obstetrics. Second edition, thoroughly revised and greatly improved. In one large royal 12mo. volume of 1028 pages, with 477 illustrations. Cloth, $4.25; leather, $5.00.

The object of this manual is to afford a convenient work of reference to students during the brief moments at their command while in attendance upon medical lectures. It is a favorable sign that it has been found necessary, in a short space of time, to issue a new and carefully revised edition. The illustrations are very numerous and unusually clear, and each part seems to have received its due share of attention. We can conceive such a work to be useful, not only to students, but to practitioners as well. It reflects credit upon the industry and energy of its able editor.—*Boston Medical and Surgical Journal*, Sept. 3, 1874.

We can say with the strictest truth that it is the best work of the kind with which we are acquainted. It embodies in a condensed form all recent contributions to practical medicine, and is therefore useful to every busy practitioner throughout our country, besides being admirably adapted to the use of students of medicine. The book is faithfully and ably executed.—*Charleston Medical Journal*, April, 1875.

NEILL, JOHN, M. D., and SMITH, F. G., M. D.,

Late Surgeon to the Penna. Hospital. *Prof. of the Institutes of Med. in the Univ. of Penna.*

An Analytical Compendium of the Various Branches of Medical Science, for the use and examination of Students. A new edition, revised and improved. In one large royal 12mo. volume of 974 pages, with 374 woodcuts. Cloth, $4; leather, $4.75.

LUDLOW, J. L., M. D.,

Consulting Physician to the Philadelphia Hospital, etc.

A Manual of Examinations upon Anatomy, Physiology, Surgery, Practice of Medicine, Obstetrics, Materia Medica, Chemistry, Pharmacy and Therapeutics. To which is added a Medical Formulary. 3d edition, thoroughly revised, and greatly enlarged. In one 12mo. volume of 816 pages, with 370 illustrations. Cloth, $3.25; leather, $3.75.

The arrangement of this volume in the form of question and answer renders it especially suitable for the office examination of students, and for those preparing for graduation.

DUNGLISON, ROBLEY, M. D.,

Late Professor of Institutes of Medicine in the Jefferson Medical College of Philadelphia.

MEDICAL LEXICON; A Dictionary of Medical Science: Containing a concise Explanation of the various Subjects and Terms of Anatomy, Physiology, Pathology, Hygiene, Therapeutics, Pharmacology, Pharmacy, Surgery, Obstetrics, Medical Jurisprudence and Dentistry, Notices of Climate and of Mineral Waters, Formulæ for Officinal, Empirical and Dietetic Preparations, with the Accentuation and Etymology of the Terms, and the French and other Synonymes, so as to constitute a French as well as an English Medical Lexicon. Edited by RICHARD J. DUNGLISON, M. D. In one very large and handsome royal octavo volume of 1139 pages. Cloth, $6.50; leather, raised bands, $7.50; very handsome half Russia, raised bands, $8.

The object of the author, from the outset, has not been to make the work a mere lexicon or dictionary of terms, but to afford under each word a condensed view of its various medical relations, and thus to render the work an epitome of the existing condition of medical science. Starting with this view, the immense demand which has existed for the work has enabled him, in repeated revisions, to augment its completeness and usefulness, until at length it has attained the position of a recognized and standard authority wherever the language is spoken. Special pains have been taken in the preparation of the present edition to maintain this enviable reputation. The additions to the vocabulary are more numerous than in any previous revision, and particular attention has been bestowed on the accentuation, which will be found marked on every word. The typographical arrangement has been greatly improved, rendering reference much more easy, and every care has been taken with the mechanical execution. The volume now contains the matter of at least four ordinary octavos.

About the first book purchased by the medical student is the Medical Dictionary. The lexicon explanatory of technical terms is simply a *sine qua non.* In a science so extensive and with such collaterals as medicine, it is as much a necessity also to the practising physician. To meet the wants of students and most physicians the dictionary must be condensed while comprehensive, and practical while perspicacious. It was because Dunglison's met these indications that it became at once the dictionary of general use wherever medicine was studied in the English language. In no former revision have the alterations and additions been so great. The chief terms have been set in black letter, while the derivatives follow in small caps; an arrangement which greatly facilitates reference. —*Cincinnati Lancet and Clinic*, Jan. 10, 1874.

A book of which every American ought to be proud. When the learned author of the work passed away, probably all of us feared lest the book should not maintain its place in the advancing science whose terms it defines. Fortunately, Dr. Richard J. Dunglison, having assisted his father in the revision of several editions of the work, and having been, therefore, trained in the methods and imbued with the spirit of the book, has been able to edit it as a work of the kind should be edited—to carry it on steadily, without jar or interruption, along the grooves of thought it has travelled during its lifetime. To show the magnitude of the task which Dr. Dunglison has assumed and carried through, it is only necessary to state that more than six thousand new subjects have been added in the present edition.—*Philadelphia Medical Times*, Jan. 3, 1874.

It has the rare merit that it certainly has no rival in the English language for accuracy and extent of references.—*London Medical Gazette.*

HOBLYN, RICHARD D., M. D.

A Dictionary of the Terms Used in Medicine and the Collateral Sciences. Revised, with numerous additions, by ISAAC HAYS, M. D., late editor of The American Journal of the Medical Sciences. In one large royal 12mo. volume of 520 double-columned pages. Cloth, $1.50; leather, $2.00.

It is the best book of definitions we have, and ought always to be upon the student's table.—*Southern Medical and Surgical Journal.*

STUDENTS' SERIES OF MANUALS.

A Series of Fifteen Manuals, for the use of Students and Practitioners of Medicine and Surgery, written by eminent Teachers or Examiners, and issued in pocket-size 12mo. volumes of 300-540 pages, richly illustrated and at a low price. The following volumes are now ready: TREVES' *Manual of Surgery*, by various writers, in three volumes, each, $2; BELL'S *Comparative Physiology and Anatomy*, $2; GOULD'S *Surgical Diagnosis*, $2; ROBERTSON'S *Physiological Physics*, $2; BRUCE'S *Materia Medica and Therapeutics*, $1.50; POWER'S *Human Physiology*, $1.50; CLARKE and LOCKWOOD'S *Dissectors' Manual*, $1.50; RALFE'S *Clinical Chemistry*, $1.50; TREVES' *Surgical Applied Anatomy*, $2; PEPPER'S *Surgical Pathology*, $2; and KLEIN'S *Elements of Histology*, $1.50. The following are in press: BELLAMY'S *Operative Surgery*, PEPPER'S *Forensic Medicine*, and CURNOW'S *Medical Applied Anatomy*. For separate notices see index on last page.

SERIES OF CLINICAL MANUALS.

In arranging for this Series it has been the design of the publishers to provide the profession with a collection of authoritative monographs on important clinical subjects in a cheap and portable form. The volumes will contain about 550 pages and will be freely illustrated by chromo-lithographs and woodcuts. The following volumes are now ready: MARSH on the *Joints*, $2; OWEN on *Surgical Diseases of Children*, $2; MORRIS on *Surgical Diseases of the Kidney*, $2.25; PICK on *Fractures and Dislocations*, $2; BUTLIN on the *Tongue*, $3.50; TREVES on *Intestinal Obstruction*, $2; and SAVAGE on *Insanity and Allied Neuroses*, $2. The following will be ready shortly: HUTCHINSON on *Syphilis*. The following are in active preparation: CARTER & FROST'S *Ophthalmic Surgery*, BRYANT on the *Breast*, BROADBENT on the *Pulse*, LUCAS on *Diseases of the Urethra*, and BALL on the *Rectum and Anus*. For separate notices see index on last page.

GRAY, HENRY, F. R. S.,

Lecturer on Anatomy at St. George's Hospital, London.

Anatomy, Descriptive and Surgical. The Drawings by H. V. CARTER, M. D., and Dr. WESTMACOTT. The dissections jointly by the AUTHOR and Dr. CARTER. With an Introduction on General Anatomy and Development by T. HOLMES, M. A., Surgeon to St. George's Hospital. Edited by T. Pickering Pick, F. R. C. S., Surgeon to and Lecturer on Anatomy at St. George's Hospital, London, Examiner in Anatomy, Royal College of Surgeons of England. A new American from the tenth enlarged and improved London edition. To which is added the second American from the latest English edition of LANDMARKS, MEDICAL AND SURGICAL, by LUTHER HOLDEN, F. R. C. S., author of "Human Osteology," "A Manual of Dissections," etc. In one imperial octavo volume of 1023 pages, with 564 large and elaborate engravings on wood. Cloth, $6.00; leather, $7.00; very handsome half Russia, raised bands, $7.50.

This work covers a more extended range of subjects than is customary in the ordinary text-books, giving not only the details necessary for the student, but also the application to those details to the practice of medicine and surgery. It thus forms both a guide for the learner and an admirable work of reference for the active practitioner. The engravings form a special feature in the work, many of them being the size of nature, nearly all original, and having the names of the various parts printed on the body of the cut, in place of figures of reference with descriptions at the foot. They thus form a complete and splendid series, which will greatly assist the student in forming a clear idea of Anatomy, and will also serve to refresh the memory of those who may find in the exigencies of practice the necessity of recalling the details of the dissecting-room. Combining, as it does, a complete Atlas of Anatomy with a thorough treatise on systematic, descriptive and applied Anatomy, the work will be found of great service to all physicians who receive students in their offices, relieving both preceptor and pupil of much labor in laying the groundwork of a thorough medical education.

Landmarks, Medical and Surgical, by the distinguished Anatomist, Mr. Luther Holden, has been appended to the present edition as it was to the previous one. This work gives in a clear, condensed and systematic way all the information by which the practitioner can determine from the external surface of the body the position of internal parts. Thus complete, the work, it is believed, will furnish all the assistance that can be rendered by type and illustration in anatomical study.

This well-known work comes to us as the latest American from the tenth English edition. As its title indicates, it has passed through many hands and has received many additions and revisions. The work is not susceptible of more improvement. Taking it all in all, its size, manner of make-up, its character and illustrations, its general accuracy of description, its practical aim, and its perspicuity of style, it is the Anatomy best adapted to the wants of the student and practitioner.—*Medical Record, Sept.* 15, 1883.

There is probably no work used so universally by physicians and medical students as this one. It is deserving of the confidence that they repose in it. If the present edition is compared with that issued two years ago, one will readily see how much it has been improved in that time. Many pages have been added to the text, especially in those parts that treat of histology, and many new cuts have been introduced and old ones modified. —*Journal of the American Medical Association*, Sept. 1, 1883.

ALSO FOR SALE SEPARATE—

HOLDEN, LUTHER, F. R. C. S.,

Surgeon to St. Bartholomew's and the Foundling Hospitals, London.

Landmarks, Medical and Surgical. Second American from the latest revised English edition, with additions by W. W. KEEN, M. D., Professor of Artistic Anatomy in the Pennsylvania Academy of the Fine Arts, formerly Lecturer on Anatomy in the Philadelphia School of Anatomy. In one handsome 12mo. volume of 148 pages. Cloth, $1.00.

This little book is all that can be desired within its scope, and its contents will be found simply invaluable to the young surgeon or physician, since they bring before him such data as he requires at every examination of a patient. It is written in language so clear and concise that one ought almost to learn it by heart. It teaches diagnosis by external examination, ocular and palpable, of the body, with such anatomical and physiological facts as directly bear on the subject. It is eminently the student's and young practitioner's book.—*Physician and Surgeon*, Nov. 1881.

The study of these Landmarks by both physicians and surgeons is much to be encouraged. It inevitably leads to a progressive education of both the eye and the touch, by which the recognition of disease or the localization of injuries is vastly assisted. One thoroughly familiar with the facts here taught is capable of a degree of accuracy and a confidence of certainty which is otherwise unattainable. We cordially recommend the Landmarks to the attention of every physician who has not yet provided himself with a copy of this useful, practical guide to the correct placing of all the anatomical parts and organs.—*Canada Medical and Surgical Journal*, Dec. 1881.

WILSON, ERASMUS, F. R. S.

A System of Human Anatomy, General and Special. Edited by W. H. GOBRECHT, M. D., Professor of General and Surgical Anatomy in the Medical College of Ohio. In one large and handsome octavo volume of 616 pages, with 397 illustrations. Cloth, $4.00; leather, $5.00.

CLELAND, JOHN, M. D., F. R. S.,

Professor of Anatomy and Physiology in Queen's College, Galway.

A Directory for the Dissection of the Human Body. In one 12mo. volume of 178 pages. Cloth, $1.25.

ALLEN, HARRISON, M. D.,

Professor of Physiology in the University of Pennsylvania.

A System of Human Anatomy, Including Its Medical and Surgical Relations. For the use of Practitioners and Students of Medicine. With an Introductory Section on Histology. By E. O. SHAKESPEARE, M. D., Ophthalmologist to the Philadelphia Hospital. Comprising 813 double-columned quarto pages, with 380 illustrations on 109 full page lithographic plates, many of which are in colors, and 241 engravings in the text. In six Sections, each in a portfolio. Section I. HISTOLOGY. Section II. BONES AND JOINTS. Section III. MUSCLES AND FASCIÆ. Section IV. ARTERIES, VEINS AND LYMPHATICS. Section V. NERVOUS SYSTEM. Section VI. ORGANS OF SENSE, OF DIGESTION AND GENITO-URINARY ORGANS, EMBRYOLOGY, DEVELOPMENT, TERATOLOGY, SUPERFICIAL ANATOMY, POST-MORTEM EXAMINATIONS, AND GENERAL AND CLINICAL INDEXES. Price per Section, $3.50; also bound in one volume, cloth, $23.00; very handsome half Russia, raised bands and open back, $25.00. *For sale by subscription only. Apply to the Publishers.*

Extract from Introduction.

It is the design of this book to present the facts of human anatomy in the manner best suited to the requirements of the student and the practitioner of medicine. The author believes that such a book is needed, inasmuch as no treatise, as far as he knows, contains, in addition to the text descriptive of the subject, a systematic presentation of such anatomical facts as can be applied to practice.

A book which will be at once accurate in statement and concise in terms; which will be an acceptable expression of the present state of the science of anatomy; which will exclude nothing that can be made applicable to the medical art, and which will thus embrace all of surgical importance, while omitting nothing of value to clinical medicine,—would appear to have an excuse for existence in a country where most surgeons are general practitioners, and where there are few general practitioners who have no interest in surgery.

It is to be considered a study of applied anatomy in its widest sense—a systematic presentation of such anatomical facts as can be applied to the practice of medicine as well as of surgery. Our author is concise, accurate and practical in his statements, and succeeds admirably in infusing an interest into the study of what is generally considered a dry subject. The department of Histology is treated in a masterly manner, and the ground is travelled over by one thoroughly familiar with it. The illustrations are made with great care, and are simply superb. There is as much of practical application of anatomical points to the every-day wants of the medical clinician as to those of the operating surgeon. In fact, few general practitioners will read the work without a feeling of surprised gratification that so many points, concerning which they may never have thought before are so well presented for their consideration. It is a work which is destined to be the best of its kind in any language.—*Medical Record*, Nov. 25, 1882.

CLARKE, W. B., F.R.C.S. & LOCKWOOD, C. B., F.R.C.S.

Demonstrators of Anatomy at St. Bartholomew's Hospital Medical School, London.

The Dissector's Manual. In one pocket-size 12mo. volume of 396 pages, with 49 illustrations. Limp cloth, red edges, $1.50. See *Students' Series of Manuals*, page 4.

This is a very excellent manual for the use of the student who desires to learn anatomy. The methods of demonstration seem to us very satisfactory. There are many woodcuts which, for the most part, are good and instructive. The book is neat and convenient. We are glad to recommend it.—*Boston Medical and Surgical Journal*, Jan. 17, 1884.

TREVES, FREDERICK, F. R. C. S.,

Senior Demonstrator of Anatomy and Assistant Surgeon at the London Hospital.

Surgical Applied Anatomy. In one pocket-size 12mo. volume of 540 pages, with 61 illustrations. Limp cloth, red edges, $2.00. See *Students' Series of Manuals*, page 4.

He has produced a work which will command a larger circle of readers than the class for which it was written. This union of a thorough, practical acquaintance with these fundamental branches, quickened by daily use as a teacher and practitioner, has enabled our author to prepare a work which it would be a most difficult task to excel.—*The American Practitioner* Feb. 1884.

CURNOW, JOHN, M. D., F. R. C. P.,

Professor of Anatomy at King's College, Physician at King's College Hospital.

Medical Applied Anatomy. In one pocket-size 12mo. volume. *Preparing.* See *Students' Series of Manuals*, page 4.

BELLAMY, EDWARD, F. R. C. S.,

Senior Assistant-Surgeon to the Charing-Cross Hospital, London.

The Student's Guide to Surgical Anatomy: Being a Description of the most Important Surgical Regions of the Human Body, and intended as an Introduction to operative Surgery. In one 12mo. volume of 300 pages, with 50 illustrations. Cloth, $2.25.

HARTSHORNE'S HANDBOOK OF ANATOMY AND PHYSIOLOGY. Second edition, revised. In one royal 12mo. volume of 310 pages, with 220 woodcuts. Cloth, $1.75.

HORNER'S SPECIAL ANATOMY AND HISTOLOGY. Eighth edition, extensively revised and modified. In two octavo volumes of 1007 pages, with 320 woodcuts. Cloth, $6.00.

DRAPER, JOHN C., M. D., LL. D.,

Professor of Chemistry in the University of the City of New York.

Medical Physics. A Text-book for Students and Practitioners of Medicine. In one octavo volume of 734 pages, with 376 woodcuts, mostly original. Cloth, $4.

From the Preface.

The fact that a knowledge of Physics is indispensable to a thorough understanding of Medicine has not been as fully realized in this country as in Europe, where the admirable works of Desplats and Gariel, of Robertson and of numerous German writers constitute a branch of educational literature to which we can show no parallel. A full appreciation of this the author trusts will be sufficient justification for placing in book form the substance of his lectures on this department of science, delivered during many years at the University of the City of New York.

Broadly speaking, this work aims to impart a knowledge of the relations existing between Physics and Medicine in their latest state of development, and to embody in the pursuit of this object whatever experience the author has gained during a long period of teaching this special branch of applied science.

This elegant and useful work bears ample testimony to the learning and good judgment of the author. He has fitted his work admirably to the exigencies of the situation by presenting the reader with brief, clear and simple statements of such propositions as he is by necessity required to master. The subject matter is well arranged, liberally illustrated and carefully indexed. That it will take rank at once among the text-books is certain, and it is to be hoped that it will find a place upon the shelf of the practical physician, where, as a book of reference, it will be found useful and agreeable.—*Louisville Medical News*, September 26, 1885.

Certainly we have no text-book as full as the excellent one he has prepared. It begins with a statement of the properties of matter and energy. After these the special departments of physics are explained, acoustics, optics, heat, electricity and magnetism, closing with a section on electro-biology. The applications of all these to physiology and medicine are kept constantly in view. The text is amply illustrated and the many difficult points of the subject are brought forward with remarkable clearness and ability.—*Medical and Surgical Reporter*, July 18, 1885.

That this work will greatly facilitate the study of medical physics is apparent upon even a mere cursory examination. It is marked by that scientific accuracy which always characterizes Dr. Draper's writings. Its peculiar value lies in the fact that it is written from the standpoint of the medical man. Hence much is omitted that appears in a mere treatise on physical science, while much is inserted of peculiar value to the physician.—*Medical Record*, August 22, 1885.

ROBERTSON, J. McGREGOR, M. A., M. B.,

Muirhead Demonstrator of Physiology, University of Glasgow.

Physiological Physics. In one 12mo. volume of 537 pages, with 219 illustrations. Limp cloth, $2.00. See *Students' Series of Manuals*, page 4.

The title of this work sufficiently explains the nature of its contents. It is designed as a manual for the student of medicine, an auxiliary to his text-book in physiology, and it would be particularly useful as a guide to his laboratory experiments. It will be found of great value to the practitioner. It is a carefully prepared book of reference, concise and accurate, and as such we heartily recommend it.—*Journal of the American Medical Association*, Dec. 6, 1884.

DALTON, JOHN C., M. D.,

Professor Emeritus of Physiology in the College of Physicians and Surgeons, New York.

Doctrines of the Circulation of the Blood. A History of Physiological Opinion and Discovery in regard to the Circulation of the Blood. In one handsome 12mo. volume of 293 pages. Cloth, $2.

Dr. Dalton's work is the fruit of the deep research of a cultured mind, and to the busy practitioner it cannot fail to be a source of instruction. It will inspire him with a feeling of gratitute and admiration for those plodding workers of olden times, who laid the foundation of the magnificent temple of medical science as it now stands.—*New Orleans Medical and Surgical Journal*, Aug. 1885.

In the progress of physiological study no fact was of greater moment, none more completely revolutionized the theories of teachers, than the discovery of the circulation of the blood. This explains the extraordinary interest it has to all medical historians. The volume before us is one of three or four which have been written within a few years by American physicians. It is in several respects the most complete. The volume, though small in size, is one of the most creditable contributions from an American pen to medical history that has appeared.—*Med. & Surg. Rep.*, Dec. 6, 1884.

BELL, F. JEFFREY, M. A.,

Professor of Comparative Anatomy at King's College, London.

Comparative Physiology and Anatomy. In one 12mo. volume of 561 pages, with 229 illustrations. Limp cloth, $2.00. See *Students' Series of Manuals*, page 4.

The manual is preëminently a student's book—clear and simple in language and arrangement. It is well and abundantly illustrated, and is readable and interesting. On the whole we consider it the best work in existence in the English language to place in the hands of the medical student.—*Bristol Medico-Chirurgical Journal*, Mar., 1886.

ELLIS, GEORGE VINER,

Emeritus Professor of Anatomy in University College, London.

Demonstrations of Anatomy. Being a Guide to the Knowledge of the Human Body by Dissection. From the eighth and revised London edition. In one very handsome octavo volume of 716 pages, with 249 illustrations. Cloth, $4.25; leather, $5.25.

ROBERTS, JOHN B., A. M., M. D.,

Prof. of Applied Anat. and Oper. Surg. in Phila. Polyclinic and Coll. for Graduates in Medicine.

The Compend of Anatomy. For use in the dissecting-room and in preparing for examinations. In one 16mo. volume of 196 pages. Limp cloth, 75 cents.

DALTON, JOHN C., M. D.,

Professor of Physiology in the College of Physicians and Surgeons, New York, etc.

A Treatise on Human Physiology. Designed for the use of Students and Practitioners of Medicine. Seventh edition, thoroughly revised and rewritten. In one very handsome octavo volume of 722 pages, with 252 beautiful engravings on wood. Cloth, $5.00; leather, $6.00; very handsome half Russia, raised bands, $6.50.

This edition of Dr. Dalton's well-known work bears evidence of having been thoroughly and carefully revised. From the first appearance of the book it has been a favorite, owing as well to the author's renown as an oral teacher as to the charm of simplicity with which, as a writer, he always succeeds in investing even intricate subjects It must be gratifying to him to observe the frequency with which his work, written for students and practitioners, is quoted by other writers on physiology. This fact attests its value, and, in great measure, its originality. It now needs no such seal of approbation, however, for the thousands who have studied it in its various editions have never been in any doubt as to its sterling worth.—*N. Y. Medical Journal and Obstetrical Review*, Oct. 1882.

Professor Dalton's well-known and deservedly-appreciated work has long passed the stage at which it could be reviewed in the ordinary sense. The work is eminently one for the medical practitioner, since it treats most fully of those branches of physiology which have a direct bearing on the diagnosis and treatment of disease. The work is one which we can highly recommend to all our readers.—*Dublin Journal of Medical Science*, Feb.'83.

Certainly no physiological work as ever issued from the press that presented its subject-matter in a clearer and more attractive light. Almost every page bears evidence of the exhaustive revision that has taken place. The material is placed in a more compact form, yet its delightful charm is retained, and no subject is thrown into obscurity. Altogether this edition is far in advance of any previous one, and will tend to keep the profession posted as to the most recent additions to our physiological knowledge.—*Michigan Medical News*, April, 1882.

One can scarcely open a college catalogue that does not have mention of Dalton's *Physiology* as the recommended text or consultation-book. For American students we would unreservedly recommend Dr. Dalton's work.—*Va. Med. Monthly, July,'82.*

FOSTER, MICHAEL, M. D., F. R. S.,

Prelector in Physiology and Fellow of Trinity College, Cambridge, England.

Text-Book of Physiology. Third American from the fourth English edition, with notes and additions by E. T. REICHERT, M. D., Professor of Physiology in the University of Pennsylvania. In one handsome royal 12mo. volume of 908 pages, with 271 illustrations. Cloth, $3.25; leather, $3.75.

Dr. Foster's work upon physiology is so well-known as a text-book in this country, that it needs but little to be said in regard to it. There is scarcely a medical college in the United States where it is not in the hands of the students. The author, more than any other writer with whom we are acquainted, seems to understand what portions of the science are essential for students to know and what may be passed over by them as not important. From the beginning to the end, physiology is taught in a systematic manner. To this third American edition numerous additions, corrections and alterations have been made, so that in its present form the usefulness of the book will be found to be much increased.—*Cincinnati Medical News*, July 1885.

For several years Foster's *Physiology* has occupied a peculiar and quite enviable position among the text-books on this most important branch of medicine. In the highest sense scientific, it should nevertheless be the constant companion of every student of medicine. To the student who is not engaged in special physiological study it should be the most constant book of reference, while to him who is specially engaged in physiological work it is an absolute necessity.—*Journal of the American Medical Association*, August 29, 1885.

POWER, HENRY, M. B., F. R. C. S.,

Examiner in Physiology, Royal College of Surgeons of England.

Human Physiology. In one handsome pocket-size 12mo. volume of 396 pages with 47 illustrations. Cloth, $1.50. See *Students' Series of Manuals*, page 3.

The prominent character of this work is that of judicious condensation, in which an able and successful effort appears to have been made by its accomplished author to teach the greatest number of facts in the fewest possible words. The result is a specimen of concentrated intellectual pabulum seldom surpassed, which ought to be carefully ingested and digested by every practitioner who desires to keep himself well informed upon this most progressive of the medical sciences. The volume is one which we cordially recommend to every one of our readers.—*The American Journal of the Medical Sciences*, October, 1884.

This little work is deserving of the highest praise, and we can hardly conceive how the main facts of this science could have been more clearly or concisely stated. The price of the work is such as to place it within the reach of all, while the excellence of its text will certainly secure for it most favorable commendation —*Cincinnati Lancet and Clinic*, Feb. 16, 1884.

SIMON, W., Ph. D., M. D.,

Professor of Chemistry and Toxicology in the College of Physicians and Surgeons, Baltimore, and Professor of Chemistry in the Maryland College of Pharmacy.

Manual of Chemistry. A Guide to Lectures and Laboratory work for Beginners in Chemistry. A Text-book, specially adapted for Students of Pharmacy and Medicine. In one 8vo. vol. of 410 pp., with 16 woodcuts and 7 plates, mostly of actual deposits, with colors illustrating 56 of the most important chemical reactions. Cloth, $3.00; also without plates, cloth, $2.50.

This book supplies a want long felt by students of medicine and pharmacy, and is a concise but thorough treatise on the subject. The long experience of the author as a teacher in schools of medicine and pharmacy is conspicuous in the perfect adaptation of the work to the special needs of the student of these branches. The colored plates, beautifully executed, illustrating precipitates of various reactions, form a novel and valuable feature of the book, and cannot fail to be appreciated by both student and teacher as a help over the hard places of the science.—*Maryland Medical Journal*, Nov. 22, 1884.

Wöhler's Outlines of Organic Chemistry. Edited by FITTIG. Translated by IRA REMSEN, M. D., Ph. D. In one 12mo. volume of 550 pages. Cloth, $3.

LEHMANN'S MANUAL OF CHEMICAL PHYSIOLOGY. In one octavo volume of 327 pages, with 41 illustrations. Cloth, $2.25.

CARPENTER'S HUMAN PHYSIOLOGY. Edited by HENRY POWER. In one octavo volume.

CARPENTER'S PRIZE ESSAY ON THE USE AND ABUSE OF ALCOHOLIC LIQUORS IN HEALTH AND DISEASE. With explanations of scientific words. Small 12mo. 178 pages. Cloth, 60 cents.

GALLOWAY'S QUALITATIVE ANALYSIS.

FRANKLAND, E., D. C. L., F. R. S., & JAPP, F. R., F. I. C.,

Professor of Chemistry in the Normal School of Science, London.

Assist. Prof. of Chemistry in the Normal School of Science, London.

Inorganic Chemistry. In one handsome octavo volume of 677 pages with 51 woodcuts and 2 plates. Cloth, $3.75; leather, $4.75.

This work should supersede other works of its class in the medical colleges. It is certainly better adapted than any work upon chemistry, with which we are acquainted, to impart that clear and full knowledge of the science which students of medicine should have. Physicians who feel that their chemical knowledge is behind the times, would do well to devote some of their leisure time to the study of this work. The descriptions and demonstrations are made so plain that there is no difficulty in understanding them.—*Cincinnati Medical News*, January, 1886.

This excellent treatise will not fail to take its place as one of the very best on the subject of which it treats. We have been much pleased with the comprehensive and lucid manner in which the difficulties of chemical notation and nomenclature have been cleared up by the writers. It shows on every page that the problem of rendering the obscurities of this science easy of comprehension has long and successfully engaged the attention of the authors.—*Medical and Surgical Reporter*, October 31, 1885.

FOWNES, GEORGE, Ph. D.

A Manual of Elementary Chemistry; Theoretical and Practical. Embodying WATTS' *Physical Inorganic Chemistry.* New American edition. In one large royal 12mo. volume of 1061 pages, with 168 illustrations on wood and a colored plate. Cloth, $2.75; leather, $3.25.

Fownes' Chemistry has been a standard text-book upon chemistry for many years. Its merits are very fully known by chemists and physicians everywhere in this country and in England. As the science has advanced by the making of new discoveries, the work has been revised so as to keep it abreast of the times. It has steadily maintained its position as a text book with medical students. In this work are treated fully: Heat, Light and Electricity, including Magnetism. The influence exerted by these forces in chemical action upon health and disease, etc., is of the most important kind, and should be familiar to every medical practitioner. We can commend the work as one of the very best text-books upon chemistry extant.—*Cincinnati Medical News*, October, 1885.

Of all the works on chemistry intended for the use of medical students, Fownes' *Chemistry* is perhaps the most widely used. Its popularity is based upon its excellence. This last edition contains all of the material found in the previous, and it is also enriched by the addition of Watts' *Physical and Inorganic Chemistry.* All of the matter is brought to the present standpoint of chemical knowledge. We may safely predict for this work a continuance of the fame and favor it enjoys among medical students.—*New Orleans Medical and Surgical Journal*, March, 1886.

ATTFIELD, JOHN, Ph. D.,

Professor of Practical Chemistry to the Pharmaceutical Society of Great Britain, etc.

Chemistry, General, Medical and Pharmaceutical; Including the Chemistry of the U. S. Pharmacopœia. A Manual of the General Principles of the Science, and their Application to Medicine and Pharmacy. A new American, from the tenth English edition, specially revised by the Author. In one handsome royal 12mo. volume of 728 pages, with 87 illustrations. Cloth, $2.50; leather, $3.00.

A text-book which passes through ten editions in sixteen years must have good qualities. This remark is certainly applicable to Attfield's Chemistry, a book which is so well known that it is hardly necessary to do more than note the appearance of this new and improved edition. It seems, however, desirable to point out that feature of the book which, in all probability, has made it so popular. There can be little doubt that it is its thoroughly practical character, the expression being used in its best sense. The author understands what the student ought to learn, and is able to put himself in the student's place and to appreciate his state of mind.—*American Chemical Journal*, April, 1884.

It is a book on which too much praise cannot be bestowed. As a text-book for medical schools it is unsurpassable in the present state of chemical science, and having been prepared with a special view towards medicine and pharmacy, it is alike indispensable to all persons engaged in those departments of science. It includes the whole chemistry of the last Pharmacopœia.—*Pacific Medical and Surgical Journal*, Jan. 1884.

BLOXAM, CHARLES L.,

Professor of Chemistry in King's College, London.

Chemistry, Inorganic and Organic. New American from the fifth London edition, thoroughly revised and much improved. In one very handsome octavo volume of 727 pages, with 292 illustrations. Cloth, $3.75; leather, $4.75.

Comment from us on this standard work is almost superfluous. It differs widely in scope and aim from that of Attfield, and in its way is equally beyond criticism. It adopts the most direct methods in stating the principles, hypotheses and facts of the science. Its language is so terse and lucid, and its arrangement of matter so logical in sequence that the student never has occasion to complain that chemistry is a hard study. Much attention is paid to experimental illustrations of chemical principles and phenomena, and the mode of conducting these experiments. The book maintains the position it has always held as one of the best manuals of general chemistry in the English language.—*Detroit Lancet*, Feb. 1884.

REMSEN, IRA, M. D., Ph. D.,

Professor of Chemistry in the Johns Hopkins University, Baltimore.

Principles of Theoretical Chemistry, with special reference to the Constitution of Chemical Compounds. Second and revised edition. In one handsome royal 12mo. volume of 240 pages. Cloth, $1.75.

That in so few years a second edition has been called for indicates that many chemical teachers have been found ready to endorse its plan and to adopt its methods. In this edition a considerable proportion of the book has been rewritten, much new matter has been added and the whole has been brought up to date. We earnestly commend this book to every student of chemistry.—*American Journal of Science*, March, 1884.

CHARLES, T. CRANSTOUN, M. D., F. C. S., M. S.,

Formerly Asst. Prof. and Demonst. of Chemistry and Chemical Physics, Queen's College, Belfast.

The Elements of Physiological and Pathological Chemistry. A Handbook for Medical Students and Practitioners. Containing a general account of Nutrition, Foods and Digestion, and the Chemistry of the Tissues, Organs, Secretions and Excretions of the Body in Health and in Disease. Together with the methods for preparing or separating their chief constituents, as also for their examination in detail, and an outline syllabus of a practical course of instruction for students. In one handsome octavo volume of 463 pages, with 38 woodcuts and 1 colored plate. Cloth, $3.50.

This is, we believe, the first complete work of the kind in the English language, and may well serve to show what progress is being made in medicine. The student will find condensed in one volume such a store of knowledge as would formerly have cost him much reading to gather. The book will fully repay anyone to read, and every library should have it for reference.—*New Orleans Medical and Surgical Journal*, April, 1885.

Dr. Charles is fully impressed with the importance and practical reach of his subject, and he has treated it in a competent and instructive manner. We cannot recommend a better book than the present. In fact, it fills a gap in medical textbooks, and that is a thing which can rarely be said nowadays. Dr. Charles has devoted much space to the elucidation of urinary mysteries. He does this with much detail, and yet in a practical and intelligible manner. In fact, the author has filled his book with many practical hints.—*Medical Record*, December 20, 1884.

HOFFMANN, F., A.M., Ph.D., & POWER F.B., Ph.D.,

Public Analyst to the State of New York. *Prof. of Anal. Chem. in the Phil. Coll. of Pharmacy.*

A Manual of Chemical Analysis, as applied to the Examination of Medicinal Chemicals and their Preparations. Being a Guide for the Determination of their Identity and Quality, and for the Detection of Impurities and Adulterations. For the use of Pharmacists, Physicians, Druggists and Manufacturing Chemists, and Pharmaceutical and Medical Students. Third edition, entirely rewritten and much enlarged. In one very handsome octavo volume of 621 pages, with 179 illustrations. Cloth, $4.25.

We congratulate the author on the appearance of the third edition of this work, published for the first time in this country also. It is admirable and the information it undertakes to supply is both extensive and trustworthy. The selection of processes for determining the purity of the substances of which it treats is excellent and the description of them singularly explicit. Moreover, it is exceptionally free from typographical errors. We have no hesitation in recommending it to those who are engaged either in the manufacture or the testing of medicinal chemicals.—*London Pharmaceutical Journal and Transactions*, 1883.

CLOWES, FRANK, D. Sc., London,

Senior Science-Master at the High School, Newcastle-under-Lyme, etc.

An Elementary Treatise on Practical Chemistry and Qualitative Inorganic Analysis. Specially adapted for use in the Laboratories of Schools and Colleges and by Beginners. Third American from the fourth and revised English edition. In one very handsome royal 12mo. volume of 387 pages, with 55 illustrations. Cloth, $2.50.

The style is clear, the language terse and vigorous. Beginning with a list of apparatus necessary for chemical work, he gradually unfolds the subject from its simpler to its more complex divisions. It is the most readable book of the kind we have yet seen, and is without doubt a systematic, intelligible and fully equipped laboratory guide and text book.—*Medical Record*, July 18, 1885.

We may simply repeat the favorable opinion which we expressed after the examination of the previous edition of this work. It is practical in its aims, and accurate and concise in its statements.—*American Journal of Pharmacy*, August, 1885.

RALFE, CHARLES H., M. D., F. R. C. P.,

Assistant Physician at the London Hospital.

Clinical Chemistry. In one pocket-size 12mo. volume of 314 pages, with 16 illustrations. Limp cloth, red edges, $1.50. See *Students' Series of Manuals*, page 4.

This is one of the most instructive little works that we have met with in a long time. The author is a physician and physiologist, as well as a chemist, consequently the book is unqualifiedly practical, telling the physician just what he ought to know, of the applications of chemistry in medicine. Dr. Ralfe is thoroughly acquainted with the latest contributions to his science, and it is quite refreshing to find the subject dealt with so clearly and simply, yet in such evident harmony with the modern scientific methods and spirit.—*Medical Record*, February 2, 1884.

CLASSEN, ALEXANDER,

Professor in the Royal Polytechnic School, Aix-la-Chapelle.

Elementary Quantitative Analysis. Translated, with notes and additions, by EDGAR F. SMITH, Ph. D., Assistant Professor of Chemistry in the Towne Scientific School, University of Penna. In one 12mo. volume of 324 pages, with 36 illust. Cloth, $2.00.

It is probably the best manual of an elementary nature extant insomuch as its methods are the best. It teaches by examples, commencing with single determinations, followed by separations, and then advancing to the analysis of minerals and such products as are met with in applied chemistry. It is an indispensable book for students in chemistry.—*Boston Journal of Chemistry*, Oct. 1878.

GREENE, WILLIAM H., M. D.,

Demonstrator of Chemistry in the Medical Department of the University of Pennsylvania.

A Manual of Medical Chemistry. For the use of Students. Based upon Bowman's Medical Chemistry. In one 12mo. volume of 310 pages, with 74 illus. Cloth, $1.75.

It is a concise manual of three hundred pages, giving an excellent summary of the best methods of analyzing the liquids and solids of the body, both for the estimation of their normal constituents and the recognition of compounds due to pathological conditions. The detection of poisons is treated with sufficient fulness for the purpose of the student or practitioner.—*Boston Jl. of Chem.* June, '81.

BRUNTON, T. LAUDER, M.D., D.Sc., F.R.S., F.R.C.P.,

Lecturer on Materia Medica and Therapeutics at St. Bartholomew's Hospital, London, etc.

A Text-book of Pharmacology, Therapeutics and Materia Medica Including the Pharmacy, the Physiological Action and the Therapeutical Uses of Drugs In one handsome octavo volume of 1033 pages, with 188 illustrations. Cloth, $5.50 leather, $6.50.

It is a scientific treatise worthy to be ranked with the highest productions in physiology, either in our own or any other language. Everything is practical, the dry, hard facts of physiology being pressed into service and applied to the treatment of the commonest complaints. The information is so systematically arranged that it is available for immediate use. The index is so carefully compiled that a reference to any special point is at once obtainable. Dr. Brunton is never satisfied with vague generalities, but gives clear and precise directions for prescribing the various drugs and preparations. We congratulate students on being at last placed in possession of a scientific treatise of enormous practical importance.—*The London Lancet*, June 27, 1885.

Of all the numerous publications of this year upon the subject of Pharmacology the comprehensive work of Brunton is clearly the most important, and is beyond question the foremost English handbook of Materia Medica and Therapeutics since the appearance of Pereira's Elements of Materia Medica in 1842. It is original both in the arrangement of the subjects and in the mode of treatment, and develops in a comprehensive manner the foundation principles of the science of Pharmacology without leaving the needs of the practitioner out of sight for an instant. In fact, the author has written a book which deserves to be known far beyond the boundaries of England, and can serve as a model for the pharmacological works of the continent on account of its happy combination of theory with practice.—*Virchow's Jahresbericht*, Berlin, 1886.

PARRISH, EDWARD,

Late Professor of the Theory and Practice of Pharmacy in the Philadelphia College of Pharmacy.

A Treatise on Pharmacy: designed as a Text-book for the Student, and as a Guide for the Physician and Pharmaceutist. With many Formulæ and, Prescriptions. Fifth edition, thoroughly revised, by THOMAS S. WIEGAND, Ph. G. In one handsome octavo volume of 1093 pages, with 256 illustrations. Cloth, $5; leather, $6.

No thoroughgoing pharmacist will fail to possess himself of so useful a guide to practice, and no physician who properly estimates the value of an accurate knowledge of the remedial agents employed by him in daily practice, so far as their miscibility, compatibility and most effective methods of combination are concerned, can afford to leave this work out of the list of their works of reference. The country practitioner, who must always be in a measure his own pharmacist, will find it indispensable.—*Louisville Medical News*, March 29, 1884.

This well-known work presents itself now based upon the recently revised new Pharmacopœia. Each page bears evidence of the care bestowed upon it, and conveys valuable information from the rich store of the editor's experience. In fact, all that relates to practical pharmacy—apparatus, processes and dispensing—has been arranged and described with clearness in its various aspects, so as to afford aid and advice alike to the student and to the practical pharmacist. The work is judiciously illustrated with good woodcuts—*American Journal of Pharmacy*, January, 1884.

There is nothing to equal Parrish's *Pharmacy* in this or any other language.—*London Pharmaceutical Journal.*

HERMANN, Dr. L.,

Professor of Physiology in the University of Zurich.

Experimental Pharmacology. A Handbook of Methods for Determining the Physiological Actions of Drugs. Translated, with the Author's permission, and with extensive additions, by ROBERT MEADE SMITH, M. D., Demonstrator of Physiology in the University of Pennsylvania. In one handsome 12mo. volume of 199 pages, with 32 illustrations. Cloth, $1.50.

MAISCH, JOHN M., Phar. D.,

Professor of Materia Medica and Botany in the Philadelphia College of Pharmacy.

A Manual of Organic Materia Medica; Being a Guide to Materia Medica of the Vegetable and Animal Kingdoms. For the use of Students, Druggists, Pharmacists and Physicians. Second edition. In one handsome royal 12mo. volume of 526 pages, with 242 illustrations. Cloth, $3.00.

This work contains the substance,—the *practical* "kernel of the nut" picked out, so that the student has no superfluous labor. He can confidently accept what this work places before him, without any fear that the gist of the matter is not in it. Another merit is that the drugs are placed before him in such a manner as to simplify very much the study of them, enabling the mind to grasp them more readily. The illustrations are most excellent, being very true to nature, and are alone worth the price of the book to the student. To the practical physician and pharmacist it is a valuable work for handy reference and for keeping fresh in the memory the knowledge of materia medica and botany already acquired. We can and do heartily recommend it.—*Medical and Surgical Reporter*, Feb. 14, 1885.

BRUCE, J. MITCHELL, M. D., F. R. C. P.,

Physician and Lecturer on Materia Medica and Therapeutics at Charing Cross Hospital, London.

Materia Medica and Therapeutics. An Introduction to Rational Treatment. Fourth edition. In one pocket-size 12mo. volume of 591 pages. Limp cloth, $1.50. See *Students' Series of Manuals*, page 4.

GRIFFITH, ROBERT EGLESFIELD, M. D.

A Universal Formulary, containing the Methods of Preparing and Administering Officinal and other Medicines. The whole adapted to Physicians and Pharmaceutists. Third edition, thoroughly revised, with numerous additions, by JOHN M. MAISCH, Phar. D., Professor of Materia Medica and Botany in the Philadelphia College of Pharmacy. In one octavo volume of 775 pages, with 38 illustrations. Cloth, $4.50; leather, $5.50.

STILLÉ, A., M. D., LL. D., & MAISCH, J. M., Phar. D.,

Professor Emeritus of the Theory and Practice of Medicine and of Clinical Medicine in the University of Pennsylvania.

Prof. of Mat. Med. and Botany in Phila. College of Pharmacy, Sec'y to the American Pharmaceutical Association.

NEW EDITION.—JUST READY.

The National Dispensatory.

CONTAINING THE NATURAL HISTORY, CHEMISTRY, PHARMACY, ACTIONS AND USES OF MEDICINES INCLUDING THOSE RECOGNIZED IN THE PHARMACOPŒIAS OF THE UNITED STATES, GREAT BRITAIN AND GERMANY, WITH NUMEROUS REFERENCES TO THE FRENCH CODEX.

Fourth edition, revised to October, 1886, and covering the new British Pharmacopœia.

In one magnificent imperial octavo volume of 1794 pages, with 311 elaborate engravings. Price in cloth, $7.25; leather, raised bands, $8.00; very handsome half Russia, raised bands and open back, $9.00.

⁂ *This work will be furnished with Patent Ready Reference Thumb-letter Index for* $1.00 *in addition to the price in any style of binding.*

In this new edition of THE NATIONAL DISPENSATORY, all important changes in the recent British Pharmacopœia have been incorporated throughout the volume, while in the Addenda will be found, grouped in a convenient section of 24 pages, all therapeutical novelties which have been established in professional favor since the publication of the third edition two years ago. Detailed information is thus given of the following among the many drugs treated: Antipyrin, Cocaine Hydrochlorate, Cascara Sagrada, Fabiana, Franciscea, various new Glycerins, Gymnocladus, Hydroquinon, Hypnone, Iodol, Jacaranda, Lanolin, Menthol, Phormium, Sulphophenol, Thallin and Urethan. In this edition, as always before, THE NATIONAL DISPENSATORY may be said to be the representative of the most recent state of American, English, German and French Pharmacology, Therapeutics and Materia Medica.

The National Dispensatory is so well and favorably known on both sides of the Atlantic that scarcely anything else is left to the reviewer than to call attention to the fact that another edition of this valuable work has made its appearance. This last edition surpasses even its predecessors in thoroughness and accuracy. The fact that in 1884, when the third edition was published, no revision of the British Pharmacopœia had been made for seventeen years, has necessitated a thorough going over of the whole work in order that references might correspond to the last revision of the work of our British cousins. In addition to these changes is a fairly full *résumé*, in the form of *addenda*, of the more important drugs which have come into general use in the last two or three years.—*The American Journal of the Medical Sciences*, April, 1887.

This, the most comprehensive of the several commentaries on the Pharmacopœias of the United States, Great Britain and Germany which has yet appeared, has by this last revision been brought fully up to the existing knowledge upon the subject treated. Its references to the British Pharmacopœia have been amended for the late and much-changed new edition of that work; an "addenda" of twenty-five pages has been appended, treating of the latest and most important additions to the materia medica. This work should be in the hands of every physician and pharmacist.—*Boston Medical and Surgical Journal*, Feb. 10, 1887.

The previous editions of The National Dispensatory have from time to time been brought before our readers, and that in 1884 left apparently little to be desired, as the authors had entirely remodelled their work, and also brought its contents up to the latest possible period. The publication of the revised British Pharmacopœia has, however, necessitated another edition, embracing the numerous changes therein embodied, and the opportunity has thus been afforded of supplying information on the unofficinal additions which have, during the past two years, been made to the materia medica.—*Canadian Pharmaceutical Journal*, Feb. 1887.

FARQUHARSON, ROBERT, M. D.,

Lecturer on Materia Medica at St. Mary's Hospital Medical School.

A Guide to Therapeutics and Materia Medica. Third American edition, specially revised by the Author. Enlarged and adapted to the U. S. Pharmacopœia by FRANK WOODBURY, M. D. In one handsome 12mo. volume of 524 pages. Cloth, $2.25.

Dr. Farquharson's Therapeutics is constructed upon a plan which brings before the reader all the essential points with reference to the properties of drugs. It impresses these upon him in such a way as to enable him to take a clear view of the actions of medicines and the disordered conditions in which they must prove useful. The double-columned pages—one side containing the recognised physiological action of the medicine, and the other the disease in which observers (who are nearly always mentioned) have obtained from it good results—make a very good arrangement. The early chapter containing rules for prescribing is excellent.—*Canada Med. and Surg. Journal*, Dec. 1882.

EDES, ROBERT T., M. D.,

Jackson Professor of Clinical Medicine in Harvard University, Medical Department.

A Text-Book of Materia Medica and Therapeutics. In one octavo volume of about 600 pages, with illustrations. *Preparing.*

STILLÉ, ALFRED, M. D., LL. D.,

Professor of Theory and Practice of Med. and of Clinical Med. in the Univ. of Penna.

Therapeutics and Materia Medica. A Systematic Treatise on the Action and Uses of Medicinal Agents, including their Description and History. Fourth edition, revised and enlarged. In two large and handsome octavo volumes, containing 1936 pages. Cloth, $10.00; leather, $12.00; very handsome half Russia, raised bands, $13.00.

COATS, JOSEPH, M. D., F. F. P. S.,

Pathologist to the Glasgow Western Infirmary.

A Treatise on Pathology. In one very handsome octavo volume of 829 pages, with 339 beautiful illustrations. Cloth, $5.50; leather, $6.50.

The work before us treats the subject of Pathology more extensively than it is usually treated in similar works. Medical students as well as physicians, who desire a work for study or reference, that treats the subjects in the various departments in a very thorough manner, but without prolixity, will certainly give this one the preference to any with which we are acquainted. It sets forth the most recent discoveries, exhibits, in an interesting manner, the changes from a normal condition effected in structures by disease, and points out the characteristics of various morbid agencies, so that they can be easily recognized. But, not limited to morbid anatomy, it explains fully how the functions of organs are disturbed by abnormal conditions. There is nothing belonging to its department of medicine that is not as fully elucidated as our present knowledge will admit.—*Cincinnati Medical News*, Oct. 1883.

One of the best features of this treatise consists in the judicious admixture of foreign observation with private experience. Thus the subject is presented in a harmonious manner, facilitating the study of single topics and making the entire volume profitable and pleasant reading. The author includes in his descriptions, general pathology as well as the special pathological histology of the different systems and organs. He has succeeded in offering to students and practitioners a thoroughly acceptable work.—*Medical Record*, Dec. 22, 1883.

GREEN, T. HENRY, M. D.,

Lecturer on Pathology and Morbid Anatomy at Charing-Cross Hospital Medical School, London.

Pathology and Morbid Anatomy. Fifth American from the sixth revised and enlarged English edition. In one very handsome octavo volume of 482 pages, with 150 fine engravings. Cloth, $2.50.

The fact that this well-known treatise has so rapidly reached its sixth edition is a strong evidence of its popularity. The author is to be congratulated upon the thoroughness with which he has prepared this work. It is thoroughly abreast with all the most recent advances in pathology. No work in the English language is so admirably adapted to the wants of the student and practitioner as this, and we would recommend it most earnestly to every one.—*Nashville Journal of Medicine and Surgery*, Nov. 1884.

An extended review of such a well-known book is unnecessary. We had already regarded the book as a model of its kind, and the author's assurance that he believes the present edition to be fully up to date will be received as sufficient proof that nothing of importance has been omitted. The book has been most carefully revised, and bears upon every page the marks of the care and accuracy that have won for it an international reputation.—*New York Medical and Surgical Journal*, July 18, 1885.

WOODHEAD, G. SIMS, M. D., F. R. C. P. E.,

Demonstrator of Pathology in the University of Edinburgh.

Practical Pathology. A Manual for Students and Practitioners. In one beautiful octavo volume of 497 pages, with 136 exquisitely colored illustrations. Cloth, $6.00.

It forms a real guide for the student and practitioner who is thoroughly in earnest in his endeavor to see for himself and do for himself. To the laboratory student it will be a helpful companion, and all those who may wish to familiarize themselves with modern methods of examining morbid tissues are strongly urged to provide themselves with this manual. The numerous drawings are not fancied pictures, or merely schematic diagrams, but they represent faithfully the actual images seen under the microscope. The author merits all praise for having produced a valuable work.—*Medical Record*, May 31, 1884.

SCHÄFER, EDWARD A., F. R. S.,

Assistant Professor of Physiology in University College, London.

The Essentials of Histology. In one octavo volume of 246 pages, with 281 illustrations. Cloth, $2.25.

This short volume might be called a companion book to Green's Pathology, and fills the same place in histology the latter occupies in pathology. This book is so short, clear and satisfactory, as to invite perusal, and repay any time spent in doing so. We think the book deserving of the highest praise. —*New Orleans Med. and Surg. Journal*, Dec. 1885.

This admirable work is a cheering example of well-won success, earned by the faithful and diligent pursuit of excellence in presentation of this essential foundation of all true medical science. Since this new work of Professor Schäfer's will doubtless be speedily placed upon the list of text books required in every medical college, we feel that it needs no further recommendation at our hands.—*Am. Jour. of the Med. Sciences*, Jan. 1886.

KLEIN, E., M. D., F. R. S.,

Joint Lecturer on General Anat. and Phys. in the Med. School of St. Bartholomew's Hosp., London.

Elements of Histology. In one pocket-size 12mo. volume of 360 pages, with 181 illus. Limp cloth, red edges, $1.50. See *Students' Series of Manuals*, page 4.

This little volume, originally intended by its able author as a manual for medical students, contains much valuable information, systematically arranged, that will be acceptable to the general practitioner. It gives a graphic and lucid description of every tissue and organ in the human body; and, while small in size, it is full to overflowing with important facts in regard to these multiform and complex structures. We know of no book of its size that will prove of greater value to medical students and practitioners of medicine.—*The Southern Practitioner*, Nov. 1883.

PEPPER, A. J., M. B., M. S., F. R. C. S.,

Surgeon and Lecturer at St. Mary's Hospital, London.

Surgical Pathology. In one pocket-size 12mo. volume of 511 pages, with 81 illustrations. Limp cloth, red edges, $2.00. See *Students' Series of Manuals*, page 4.

It is not pretentious, but it will serve exceedingly well as a book of reference. It embodies a great deal of matter, extending over the whole field of surgical pathology. Its form is practical, its language is clear, and the information set forth is well-arranged, well-indexed and well-illustrated. The student will find in it nothing that is unnecessary. The list of subjects covers the whole range of surgery. The book supplies a very manifest want and should meet with success.—*New York Medical Journal*, May 31, 1884.

Cornil and Ranvier's Pathological Histology. — Translated by E. O. SHAKESPEARE, M. D., and J. HENRY C. SIMES, M. D. Octavo, 800 pp., 360 illustrations.

FLINT, AUSTIN, M. D.,

Prof. of the Principles and Practice of Med. and of Clin. Med. in Bellevue Hospital Medical College, N. Y.

A Treatise on the Principles and Practice of Medicine. Designed for the use of Students and Practitioners of Medicine. New (sixth) edition, thoroughly revised and rewritten by the Author, assisted by WILLIAM H. WELCH, M. D., Professor of Pathology, Johns Hopkins University, Baltimore, and AUSTIN FLINT, JR., M. D., LL. D., Professor of Physiology, Bellevue Hospital Medical College, N. Y. In one very handsome octavo volume of about 1170 pages, with illustrations. Cloth, $5.50; leather, $6.50; very handsome half Russia, raised bands, $7.00.

A new edition of a work of such established reputation as Flint's Medicine needs but few words to commend it to notice. It may in truth be said to embody the fruit of his labors in clinical medicine, ripened by the experience of a long life devoted to its pursuit. America may well be proud of having produced a man whose indefatigable industry and gifts of genius have done so much to advance medicine; and all English-reading students must be grateful for the work which he has left behind him. It has few equals, either in point of literary excellence, or of scientific learning, and no one can fail to study its pages without being struck by the lucidity and accuracy which characterize them. It is qualities such as these which render it so valuable for its purpose, and give it a foremost place among the text-books of this generation.—*The London Lancet*, March 12, 1887.

No text-book on the principles and practice of medicine has ever met in this country with such general approval by medical students and practitioners as the work of Professor Flint. In all the medical colleges of the United States it is the favorite work upon Practice; and, as we have stated before in alluding to it, there is no other medical work that can be so generally found in the libraries of physicians. In every state and territory of this vast country the book that will be most likely to be found in the office of a medical man, whether in city, town, village, or at some cross-roads, is Flint's *Practice.* We make this statement to a considerable extent from personal observation, and it is the testimony also of others. An examination shows that very considerable changes have been made in the sixth edition. The work may undoubtedly be regarded as fairly representing the present state of the science of medicine, and as reflecting the views of those who exemplify in their practice the present stage of progress of medical art.—*Cincinnati Medical News*, Oct. 1886.

HARTSHORNE, HENRY, M. D., LL. D.,

Lately Professor of Hygiene in the University of Pennsylvania.

Essentials of the Principles and Practice of Medicine. A Handbook for Students and Practitioners. Fifth edition, thoroughly revised and rewritten. In one royal 12mo. volume of 669 pages, with 144 illustrations. Cloth, $2.75; half bound, $3.00.

Within the compass of 600 pages it treats of the history of medicine, general pathology, general symptomatology, and physical diagnosis (including laryngoscope, ophthalmoscope, etc.), general therapeutics, nosology, and special pathology and practice. There is a wonderful amount of information contained in this work, and it is one of the best of its kind that we have seen.—*Glasgow Medical Journal*, Nov. 1882.

An indispensable book. No work ever exhibited a better average of actual practical treatment than this one; and probably not one writer in our day had a better opportunity than Dr. Hartshorne for condensing all the views of eminent practitioners into a 12mo. The numerous illustrations will be very useful to students especially. These essentials, as the name suggests, are not intended to supersede the text-books of Flint and Bartholow, but they are the most valuable in affording the means to see at a glance the whole literature of any disease, and the most valuable treatment.—*Chicago Medical Journal and Examiner*, April, 1882.

BRISTOWE, JOHN SYER, M. D., F. R. C. P.,

Physician and Joint Lecturer on Medicine at St. Thomas' Hospital, London.

A Treatise on the Practice of Medicine. Second American edition, revised by the Author. Edited, with additions, by JAMES H. HUTCHINSON, M.D., physician to the Pennsylvania Hospital. In one handsome octavo volume of 1085 pages, with illustrations. Cloth, $5.00; leather, $6.00; very handsome half Russia, raised bands, $6.50.

The book is a model of conciseness, and combines, as successfully as one could conceive it to be possible, an encyclopædic character with the smallest dimensions. It differs from other admirable text-books in the completeness with which it covers the whole field of medicine.—*Michigan Medical News*, May 10, 1880.

His accuracy in the portraiture of disease, his care in stating subtle points of diagnosis, and the faithfully given pathology of abnormal processes have seldom been surpassed. He embraces many diseases not usually considered to belong to theory and practice, as skin diseases, syphilis and insanity, but they will not be objected to by readers, as he has studied them conscientiously, and drawn from the life.—*Medical and Surgical Reporter*, December 20, 1879.

The reader will find every conceivable subject connected with the practice of medicine ably presented, in a style at once clear, interesting and concise. The additions made by Dr. Hutchinson are appropriate and practical, and greatly add to its usefulness to American readers.—*Buffalo Medical and Surgical Journal*, March, 1880.

WATSON, SIR THOMAS, M. D.,

Late Physician in Ordinary to the Queen.

Lectures on the Principles and Practice of Physic. A new American from the fifth English edition. Edited, with additions, and 190 illustrations, by HENRY HARTSHORNE, A. M., M. D., late Professor of Hygiene in the University of Pennsylvania. In two large octavo volumes of 1840 pages. Cloth, $9.00; leather, $11.00.

LECTURES ON THE STUDY OF FEVER. By A. HUDSON, M. D., M. R. I. A. In one octavo volume of 308 pages. Cloth, $2.50.

STOKES' LECTURES ON FEVER. Edited by John William Moore, M. D., F. K. Q. C. P. In one octavo volume of 280 pages. Cloth, $2.00.

A TREATISE ON FEVER. By ROBERT D. LYONS, K. C. C. In one 8vo. vol. of 354 pp. Cloth, $2.25.

LA ROCHE ON YELLOW FEVER, considered in its Historical, Pathological, Etiological and Therapeutical Relations. In two large and handsome octavo volumes of 1468 pp. Cloth, $7.00.

A CENTURY OF AMERICAN MEDICINE, 1776—1876. By Drs. E. H. CLARKE, H. J. BIGELOW, S. D. GROSS, T. G. THOMAS, and J. S. BILLINGS. In one 12mo. volume of 370 pages. Cloth, $2.25.

For Sale by Subscription Only.

A System of Practical Medicine.

BY AMERICAN AUTHORS.

EDITED BY WILLIAM PEPPER, M. D., LL. D.,

PROVOST AND PROFESSOR OF THE THEORY AND PRACTICE OF MEDICINE AND OF CLINICAL MEDICINE IN THE UNIVERSITY OF PENNSYLVANIA,

Assisted by LOUIS STARR, M. D., Clinical Professor of the Diseases of Children in the Hospital of the University of Pennsylvania.

The complete work, in five volumes, containing 5573 *pages, with* 198 *illustrations, is just ready. Price per volume, cloth,* $5; *leather,* $6; *half Russia, raised bands and open back,* $7.

In this great work American medicine is for the first time reflected by its worthiest teachers, and presented in the full development of the practical utility which is its preëminent characteristic. The most able men—from the East and the West, from the North and the South, from all the prominent centres of education, and from all the hospitals which afford special opportunities for study and practice—have united in generous rivalry to bring together this vast aggregate of specialized experience.

The distinguished editor has so apportioned the work that to each author has been assigned the subject which he is peculiarly fitted to discuss, and in which his views will be accepted as the latest expression of scientific and practical knowledge. The practitioner will therefore find these volumes a complete, authoritative and unfailing work of reference, to which he may at all times turn with full certainty of finding what he needs in its most recent aspect, whether he seeks information on the general principles of medicine, or minute guidance in the treatment of special disease. So wide is the scope of the work that, with the exception of midwifery and matters strictly surgical, it embraces the whole domain of medicine, including the departments for which the physician is accustomed to rely on special treatises, such as diseases of women and children, of the genito-urinary organs, of the skin, of the nerves, hygiene and sanitary science, and medical ophthalmology and otology. Moreover, authors have inserted the formulas which they have found most efficient in the treatment of the various affections. It may thus be truly regarded as a COMPLETE LIBRARY OF PRACTICAL MEDICINE, and the general practitioner possessing it may feel secure that he will require little else in the daily round of professional duties.

In spite of every effort to condense the vast amount of practical information furnished, it has been impossible to present it in less than 5 large octavo volumes, containing about 5600 beautifully printed pages, and embodying the matter of about 15 ordinary octavos. Illustrations are introduced wherever requisite to elucidate the text.

A detailed prospectus of the work will be sent to any address on application to the publishers.

These two volumes bring this admirable work to a close, and fully sustain the high standard reached by the earlier volumes; we have only therefore to echo the eulogium pronounced upon them. We would warmly congratulate the editor and his collaborators at the conclusion of their laborious task on the admirable manner in which, from first to last, they have performed their several duties. They have succeeded in producing a work which will long remain a standard work of reference, to which practitioners will look for guidance, and authors will resort to for facts. From a literary point of view, the work is without any serious blemish, and in respect of production, it has the beautiful finish that Americans always give their works.—*Edinburgh Medical Journal*, Jan. 1887.

* * The greatest distinctively American work on the practice of medicine, and, indeed, the superlative adjective would not be inappropriate were even all other productions placed in comparison. An examination of the five volumes is sufficient to convince one of the magnitude of the enterprise, and of the success which has attended its fulfilment.—*The Medical Age*, July 26, 1886.

Convenience and good order, with easy reference, are no less characteristic than the almost uniform excellence of the matter.—*New York Medical Journal*, June 19, 1886.

We consider it one of the grandest works on Practical Medicine in the English language. It is a work of which the profession of this country can feel proud. Written exclusively by American physicians who are acquainted with all the varieties of climate in the United States, the character of the soil, the manners and customs of the people, etc., it is peculiarly adapted to the wants of American practitioners of medicine, and it seems to us that every one of them would desire to have it. It has been truly called a "Complete Library of Practical Medicine," and the general practitioner will require little else in his round of professional duties.—*Cincinnati Medical News*, March, 1886.

Each of the volumes is provided with a most copious index, and the work altogether promises to be one which will add much to the medical literature of the present century, and reflect great credit upon the scholarship and practical acumen of its authors.—*The London Lancet*, Oct. 3, 1885.

The feeling of proud satisfaction with which the American profession sees this, its representative system of practical medicine issued to the medical world, is fully justified by the character of the work. The entire caste of the system is in keeping with the best thoughts of the leaders and followers of our home school of medicine, and the combination of the scientific study of disease and the practical application of exact and experimental knowledge to the treatment of human maladies, makes every one of us share in the pride that has welcomed Dr. Pepper's labors. Sheared of the prolixity that wearies the readers of the German school, the articles glean these same fields for all that is valuable. It is the outcome of American brains, and is marked throughout by much of the sturdy independence of thought and originality that is a national characteristic. Yet nowhere is there lack of study of the most advanced views of the day.—*North Carolina Medical Journal*, Sept. 1886.

FOTHERGILL, J. M., M. D., Edin,. M. R. C. P., Lond.,

Physician to the City of London Hospital for Diseases of the Chest.

The Practitioner's Handbook of Treatment; Or, The Principles of Therapeutics. New (third) edition. In one octavo volume of 661 pages. Cloth, $3.75; leather, $4.75. *Just ready.*

FROM THE AUTHOR'S PREFACES.

This work is not an imperfect Practice of Physic, but an attempt of an original character to explain the rationale of our therapeutic measures. First the physiology of each subject is given and then the pathology is reviewed, so far as they bear upon the treatment; next the action of remedies is examined; after which their practical application in concrete prescriptions is furnished. It is designed to supply to the practitioner reasons for the faith that is in him; and is a work on medical tactics for the bedside, rather than for the examination table. It has been carefully revised, and considerable additions have been made to it. A chapter on "The Dietary in Acute Disease and Malassimilation" indicates the growing importance of dietetics in the treatment of disease, and a second new chapter has been added on the "Management of Convalescence," which it is hoped will add value to the work.

By the same Author.

Mind and Liver. In one 12mo. volume of about 125 pages. *In press.*

REYNOLDS, J. RUSSELL, M. D.,

Professor of the Principles and Practice of Medicine in University College, London.

A System of Medicine. With notes and additions by HENRY HARTSHORNE, A. M., M. D., late Professor of Hygiene in the University of Pennsylvania. In three large and handsome octavo volumes, containing 3056 double-columned pages, with 317 illustrations. Price per volume, cloth, $5.00; sheep, $6.00; very handsome half Russia, raised bands, $6.50. Per set, cloth, $15; leather, $18; half Russia, $19.50. *Sold only by subscription.*

STILLÉ, ALFRED, M. D., LL. D.,

Professor Emeritus of the Theory and Practice of Med. and of Clinical Med. in the Univ. of Penna.

Cholera: Its Origin, History, Causation, Symptoms, Lesions, Prevention and Treatment. In one handsome 12mo. volume of 163 pages, with a chart. Cloth, $1.25. *Just ready.*

FINLAYSON, JAMES, M. D., Editor,

Physician and Lecturer on Clinical Medicine in the Glasgow Western Infirmary, etc.

Clinical Manual for the Study of Medical Cases. With Chapters by Prof. Gairdner on the Physiognomy of Disease; Prof. Stephenson on Diseases of the Female Organs; Dr. Robertson on Insanity; Dr. Gemmell on Physical Diagnosis; Dr. Coats on Laryngoscopy and Post-Mortem Examinations, and by the Editor on Case-taking, Family History and Symptoms of Disorder in the Various Systems. New edition. In one 12mo. volume of 682 pages, with 158 illustrations. Cloth, $2.50. *Just ready.*

We are pleased to see a second edition of this admirable book, which occupies a position in medical literature that previous to the first appearance of this work was unoccupied. It is essentially a practical treatise on medical diagnosis, in which every sign and symptom of disease is carefully analyzed, and their relative significance in the different affections in which they occur pointed out. From their synthesis the student can accurately determine the disease with which he has to deal. The book has no competitor, nor is it likely to have as long as future editions maintain its present standard of excellence. It is a book which will greatly aid the work of the clinical teacher, and should be thoroughly digested by every student of medicine. The general practitioner will find many practical hints in its pages, while a careful study of the work will save him from many pitfalls in diagnosis. The book, therefore, in our opinion, commends itself to a wide field of readers, and we sincerely wish it the great success which it so richly merits.—*Liverpool Medico-Chirurgical Journal*, Jan. 1887.

FENWICK, SAMUEL, M. D.,

Assistant Physcian to the London Hospital.

The Student's Guide to Medical Diagnosis. From the third revised and enlarged English edition. In one very handsome royal 12mo. volume of 328 pages, with 87 illustrations on wood. Cloth, $2.25.

HABERSHON, S. O., M. D.,

Senior Physician to and late Lect. on Principles and Practice of Med. at Guy's Hospital, London.

On the Diseases of the Abdomen; Comprising those of the Stomach, and other parts of the Alimentary Canal, Œsophagus, Cæcum, Intestines and Peritoneum. Second American from third enlarged and revised English edition. In one handsome octavo volume of 554 pages, with illustrations. Cloth, $3.50.

TANNER, THOMAS HAWKES, M. D.

A Manual of Clinical Medicine and Physical Diagnosis. Third American from the second London edition. Revised and enlarged by TILBURY FOX, M. D. In one small 12mo. volume of 362 pages, with illustrations. Cloth, $1.50.

BARTHOLOW, ROBERTS, A. M., M. D., LL. D.,

Prof. of Materia Medica and General Therapeutics in the Jefferson Med. Coll. of Phila., etc.

Medical Electricity. A Practical Treatise on the Applications of Electricity to Medicine and Surgery. New (third) edition. In one very handsome octavo volume of 308 pages, with 110 illustrations. Cloth, $2.50. *Just ready.*

FROM THE PREFACE TO THE THIRD EDITION.

It would be a mere affectation of indifference, which I am far from feeling, to refrain from the expression of my gratification that the publishers of this work have called on me to prepare a new edition, and my gratification is the greater in that the sale of this and other works on Medical Electricity afford indubitable evidence of growth in the appreciation of electricity as a remedial agent by the medical profession in general. That this force should be utilized in therapeutics, just as any drug is employed as a remedy, is a fact of the highest importance. As stated in the preface to the first edition, one of my purposes in preparing the work was to afford some aid in generalizing medical electricity. The new material which appears in this edition is chiefly practical in character, the most important additions having been made to the therapeutical sections.

RICHARDSON, B. W., M.A., M.D., LL. D., F.R.S., F.S.A.

Fellow of the Royal College of Physicians, London.

Preventive Medicine. In one octavo volume of 729 pages. Cloth, $4; leather, $5; very handsome half Russia, raised bands, $5.50.

Dr. Richardson has succeeded in producing a work which is elevated in conception, comprehensive in scope, scientific in character, systematic in arrangement, and which is written in a clear, concise and pleasant manner. He evinces the happy faculty of extracting the pith of what is known on the subject, and of presenting it in a most simple, intelligent and practical form. There is perhaps no similar work written for the general public that contains such a complete, reliable and instructive collection of data upon the diseases common to the race, their origins, causes, and the measures for their prevention. The descriptions of diseases are clear, chaste and scholarly; the discussion of the question of disease is comprehensive, masterly and fully abreast with the latest and best knowledge on the subject, and the preventive measures advised are accurate, explicit and reliable.—*The American Journal of the Medical Sciences*, April, 1884.

HARTSHORNE, HENRY, M. D., LL. D.,

Formerly Professor of Hygiene in the University of Pennsylvania, and Professor of Physiology and Diseases of Children in the Woman's Medical College of Pennsylvania.

A Household Manual of Medicine, Surgery, Nursing and Hygiene: For Daily Use in the Preservation of Health and Care of the Sick and Injured, with an Introductory Outline of Anatomy and Physiology. In one very handsome royal octavo volume of 946 pages, with 8 plates and 283 engravings. Cloth, $4.00; very handsome half Morocco, $5.00.

THE YEAR-BOOK OF TREATMENT FOR 1886.

A Comprehensive and Critical Review for Practitioners of Medicine. In one 12mo. volume of 309 pages, bound in limp cloth, $1.25.

This work presents not only a complete classified account of all the more important advances made in the treatment of disease during the year ending September 30, 1886, but also a critical estimate of the same by competent authorities. Each department of practice is fully and concisely treated, and into the consideration of each subject enter such allusions to recent pathological and clinical work as bear directly upon treatment

⁂ For special commutations with periodicals see page 3.

THE YEAR-BOOK OF TREATMENT FOR 1885.

Similar to that of 1886 above. 12mo., 320 pages. Limp cloth, $1.25.

SCHREIBER, DR. JOSEPH.

A Manual of Treatment by Massage and Methodical Muscle Exercise. Translated by WALTER MENDELSON, M. D., of New York. In one handsome octavo volume of about 300 pages, with 117 fine engravings. *Shortly.*

BROADBENT, W. H., M. D., F. R. C. P.,

Physician to and Lecturer on Medicine at St. Mary's Hospital.

The Pulse. In one 12mo. volume. *Preparing.* See *Series of Clinical Manuals*, page 4.

STURGES' INTRODUCTION TO THE STUDY OF CLINICAL MEDICINE. Being a Guide to the Investigation of Disease. In one handsome 12mo. volume of 127 pages. Cloth, $1.25.

DAVIS' CLINICAL LECTURES ON VARIOUS IMPORTANT DISEASES. By N. S. DAVIS, M. D. Edited by FRANK H. DAVIS, M. D. Second edition. 12mo. 287 pages. Cloth, $1.75.

TODD'S CLINICAL LECTURES ON CERTAIN ACUTE DISEASES. In one octavo volume of 320 pages. Cloth, $2.50.

PAVY'S TREATISE ON THE FUNCTION OF DIGESTION; its Disorders and their Treatment. From the second London edition. In one octavo volume of 238 pages. Cloth, $2.00.

BARLOW'S MANUAL OF THE PRACTICE OF MEDICINE. With additions by D. F. CONDIE, M. D. 1 vol. 8vo., pp. 603. Cloth, $2.50.

CHAMBERS' MANUAL OF DIET AND REGIMEN IN HEALTH AND SICKNESS. In one handsome octavo volume of 302 pp. Cloth, $2.75.

HOLLAND'S MEDICAL NOTES AND REFLECTIONS. 1 vol. 8vo., pp. 493. Cloth, $3.50.

FLINT, AUSTIN, M. D.,

Professor of the Principles and Practice of Medicine in Bellevue Hospital Medical College, N. Y.

A Manual of Auscultation and Percussion; Of the Physical Diagnosis of Diseases of the Lungs and Heart, and of Thoracic Aneurism. Fourth edition. In one handsome royal 12mo. volume of 278 pages, with 14 illustrations. Cloth, $1.75. *Just ready.*

The student needs a first-class text-book in which the subject is fully explained for him to study. Dr. Flint's work is just such a book. It contains the substance of the lessons which the author has for many years given in connection with practical instruction in auscultation and percussion to private classes, composed of medical students and practitioners. The fact that within a little more than two years a large edition of this manual has been exhausted, is proof of the favor with which it has been regarded by the medical profession.—*Cincinnati Medical News*, Feb. 1886.

BY THE SAME AUTHOR.

Physical Exploration of the Lungs by Means of Auscultation and Percussion. Three lectures delivered before the Philadelphia County Medical Society, 1882–83. In one handsome small 12mo. volume of 83 pages. Cloth, $1.00.

A Practical Treatise on the Physical Exploration of the Chest and the Diagnosis of Diseases Affecting the Respiratory Organs. Second and revised edition. In one handsome octavo volume of 591 pages. Cloth, $4.50.

Phthisis: Its Morbid Anatomy, Etiology, Symptomatic Events and Complications, Fatality and Prognosis, Treatment and Physical Diagnosis; In a series of Clinical Studies. In one handsome octavo volume of 442 pages. Cloth, $3.50.

A Practical Treatise on the Diagnosis, Pathology and Treatment of Diseases of the Heart. Second revised and enlarged edition. In one octavo volume of 550 pages, with a plate. Cloth, $4.

Essays on Conservative Medicine and Kindred Topics. In one very handsome royal 12mo. volume of 210 pages. Cloth, $1.38.

BROWNE, LENNOX, F. R. C. S., Edin.,

Senior Surgeon to the Central London Throat and Ear Hospital, etc.

The Throat and its Diseases. Second American from the second English edition, thoroughly revised. With 200 engravings and 120 illustrations in colors. In one very handsome imperial octavo volume of about 350 pages. *Shortly.*

GROSS, S. D., M.D., LL.D., D.C.L. Oxon., LL.D. Cantab.

A Practical Treatise on Foreign Bodies in the Air-passages. In one octavo volume of 452 pages, with 59 illustrations. Cloth, $2.75.

COHEN, J. SOLIS, M. D.,

Lecturer on Laryngoscopy and Diseases of the Throat and Chest in the Jefferson Medical College.

Diseases of the Throat and Nasal Passages. A Guide to the Diagnosis and Treatment of Affections of the Pharynx, Œsophagus, Trachea, Larynx and Nares. Third edition, thoroughly revised and rewritten, with a large number of new illustrations. In one very handsome octavo volume. *Preparing.*

SEILER, CARL, M. D.,

Lecturer on Laryngoscopy in the University of Pennsylvania.

A Handbook of Diagnosis and Treatment of Diseases of the Throat, Nose and Naso-Pharynx. Second edition. In one handsome royal 12mo. volume of 294 pages, with 77 illustrations. Cloth, $1.75.

It is one of the best of the practical text-books on this subject with which we are acquainted. The present edition has been increased in size, but its eminently practical character has been maintained. Many new illustrations have also been introduced, a case-record sheet has been added, and there are a valuable bibliography and a good index of the whole. For any one who wishes to make himself familiar with the practical management of cases of throat and nose disease, the book will be found of great value.—*New York Medical Journal*, June 9, 1883.

FULLER ON DISEASES OF THE LUNGS AND AIR-PASSAGES. Their Pathology, Physical Diagnosis, Symptoms and Treatment. From the second and revised English edition. In one octavo volume of 475 pages. Cloth, $3.50.

SLADE ON DIPHTHERIA; its Nature and Treatment, with an account of the History of its Prevalence in various Countries. Second and revised edition. In one 12mo. vol., pp. 158. Cloth, $1.25.

WALSHE ON THE DISEASES OF THE HEART AND GREAT VESSELS. Third American edition. In 1 vol. 8vo., 416 pp. Cloth, $3.00.

SMITH ON CONSUMPTION; its Early and Remediable Stages. 1 vol. 8vo., pp. 253. Cloth, $2.25.

LA ROCHE ON PNEUMONIA. 1 vol. 8vo. of 490 pages. Cloth, $3.00.

WILLIAMS ON PULMONARY CONSUMPTION; its Nature, Varieties and Treatment. With an analysis of one thousand cases to exemplify its duration. In one 8vo. vol. of 303 pp. Cloth, $2.50.

JONES' CLINICAL OBSERVATIONS ON FUNCTIONAL NERVOUS DISORDERS. Second American edition. In one handsome octavo volume of 340 pages. Cloth, $3.25.

ROSS, JAMES, M. D., F. R. C. P., LL. D.,

Senior Assistant Physician to the Manchester Royal Infirmary.

A Handbook on Diseases of the Nervous System. In one octavo volume of 725 pages, with 184 illustrations. Cloth, $4.50; leather, $5.50.

This admirable work is intended for students of medicine and for such medical men as have no time for lengthy treatises. In the present instance the duty of arranging the vast store of material at the disposal of the author, and of abridging the description of the different aspects of nervous diseases, has been performed with singular skill, and the result is a concise and philosophical guide to the department of medicine of which it treats. Dr. Ross holds such a high scientific position that any writings which bear his name are naturally expected to have the impress of a powerful intellect. In every part this handbook merits the highest praise, and will no doubt be found of the greatest value to the student as well as to the practitioner.—*Edinburgh Medical Journal*, Jan. 1887.

MITCHELL, S. WEIR, M. D.,

Physician to Orthopædic Hospital and the Infirmary for Diseases of the Nervous System, Phila., etc.

Lectures on Diseases of the Nervous System; Especially in Women. Second edition. In one 12mo. volume of 288 pages. Cloth, $1.75.

No work in our language develops or displays more features of that many-sided affection, hysteria, or gives clearer directions for its differentiation, or sounder suggestions relative to its general management and treatment. The book is particularly valuable in that it represents in the main the author's own clinical studies, which have been so extensive and fruitful as to give his teachings the stamp of authority all over the realm of medicine. The work, although written by a specialist, has no exclusive character, and the general practitioner above all others will find its perusal profitable, since it deals with diseases which he frequently encounters and must essay to treat.—*American Practitioner*, August, 1885.

HAMILTON, ALLAN McLANE, M. D.,

Attending Physician at the Hospital for Epileptics and Paralytics, Blackwell's Island, N. Y.

Nervous Diseases; Their Description and Treatment. Second edition, thoroughly revised and rewritten. In one octavo volume of 598 pages, with 72 illustrations. Cloth, $4.

When the first edition of this good book appeared we gave it our emphatic endorsement, and the present edition enhances our appreciation of the book and its author as a safe guide to students of clinical neurology. One of the best and most critical of English neurological journals, *Brain*, has characterized this book as the best of its kind in any language, which is a handsome endorsement from an exalted source. The improvements in the new edition, and the additions to it, will justify its purchase even by those who possess the old.—*Alienist and Neurologist*, April, 1882.

TUKE, DANIEL HACK, M. D.,

Joint Author of The Manual of Psychological Medicine, etc.

Illustrations of the Influence of the Mind upon the Body in Health and Disease. Designed to elucidate the Action of the Imagination. New edition. Thoroughly revised and rewritten. In one handsome octavo volume of 467 pages, with two colored plates. Cloth, $3.00.

It is impossible to peruse these interesting chapters without being convinced of the author's perfect sincerity, impartiality, and thorough mental grasp. Dr. Tuke has exhibited the requisite amount of scientific address on all occasions, and the more intricate the phenomena the more firmly has he adhered to a physiological and rational method of interpretation. Guided by an enlightened deduction, the author has reclaimed for science a most interesting domain in psychology, previously abandoned to charlatans and empirics. This book, well conceived and well written, must commend itself to every thoughtful understanding.—*New York Medical Journal*, September 6, 1884.

CLOUSTON, THOMAS S., M. D., F. R. C. P., L. R. C. S.,

Lecturer on Mental Diseases in the University of Edinburgh.

Clinical Lectures on Mental Diseases. With an Appendix, containing an Abstract of the Statutes of the United States and of the Several States and Territories relating to the Custody of the Insane. By CHARLES F. FOLSOM, M. D., Assistant Professor of Mental Diseases, Med. Dep. of Harvard Univ. In one handsome octavo volume of 541 pages, with eight lithographic plates, four of which are beautifully colored. Cloth, $4.

The practitioner as well as the student will accept the plain, practical teaching of the author as a forward step in the literature of insanity. It is refreshing to find a physician of Dr. Clouston's experience and high reputation giving the bedside notes upon which his experience has been founded and his mature judgment established. Such clinical observations cannot but be useful to the general practitioner in guiding him to a diagnosis and indicating the treatment, especially in many obscure and doubtful cases of mental disease. To the American reader Dr. Folsom's *Appendix* adds greatly to the value of the work, and will make it a desirable addition to every library.—*American Psychological Journal*, July, 1884.

☞ Dr. Folsom's *Abstract* may also be obtained separately in one octavo volume of 108 pages. Cloth, $1.50.

SAVAGE, GEORGE H., M. D.,

Lecturer on Mental Diseases at Guy's Hospital, London.

Insanity and Allied Neuroses, Practical and Clinical. In one 12mo. vol. of 551 pages, with 18 illus. Cloth, $2.00. See *Series of Clinical Manuals*, page 4.

PLAYFAIR, W. S., M. D., F. R. C. P.,

The Systematic Treatment of Nerve Prostration and Hysteria. In one handsome small 12mo. volume of 97 pages. Cloth, $1.00.

Blandford on Insanity and its Treatment: Lectures on the Treatment, Medical and Legal, of Insane Patients. In one very handsome octavo volume.

ASHHURST, JOHN, Jr., M. D.,

Professor of Clinical Surgery, Univ. of Penna., Surgeon to the Episcopal Hospital, Philadelphia.

The Principles and Practice of Surgery. New (fourth) edition, enlarged and revised. In one large and handsome octavo volume of 1114 pages, with 597 illustrations. Cloth, $6; leather, $7; half Russia, $7.50.

As with Erichsen so with Ashhurst, its position in professional favor is established, and one has now but to notice the changes, if any, in theory and practice, that are apparent in the present as compared with the preceding edition, published three years ago. The work has been brought well up to date, and is larger and better illustrated than before, and its author may rest assured that it will certainly have a "continuance of the favor with which it has heretofore been received."—*The American Journal of the Medical Sciences*, Jan. 1886.

Every advance in surgery worth notice, chronicled in recent literature, has been suitably recognized and noted in its proper place. Suffice it to say, we regard Ashhurst's Surgery, as now presented in the fourth edition, as the best single volume on surgery published in the English language, valuable alike to the student and the practitioner, to the one as a text-book, to the other as a manual of practical surgery. With pleasure we give this volume our endorsement in full.—*New Orleans Medical and Surgical Journal*, Jan., 1886.

GROSS, S. D., M. D., LL. D., D. C. L. Oxon., LL. D. Cantab.,

Emeritus Professor of Surgery in the Jefferson Medical College of Philadelphia.

A System of Surgery: Pathological, Diagnostic, Therapeutic and Operative. Sixth edition, thoroughly revised and greatly improved. In two large and beautifully-printed imperial octavo volumes containing 2382 pages, illustrated by 1623 engravings. Strongly bound in leather, raised bands, $15; half Russia, raised bands, $16.

Dr. Gross' *System of Surgery* has long been the standard work on that subject for students and practitioners.—*London Lancet*, May 10, 1884.

The work as a whole needs no commendation. Many years ago it earned for itself the enviable reputation of the leading American work on surgery, and it is still capable of maintaining that standard. A considerable amount of new material has been introduced, and altogether the distinguished author has reason to be satisfied that he has placed the work fully abreast of the state of our knowledge.—*Med. Record*, Nov. 18, 1882.

His *System of Surgery*, which, since its first edition in 1859, has been a standard work in this country as well as in America, in "the whole domain of surgery," tells how earnest and laborious and wise a surgeon he was, how thoroughly he appreciated the work done by men in other countries, and how much he contributed to promote the science and practice of surgery in his own. There has been no man to whom America is so much indebted in this respect as the Nestor of surgery.—*British Medical Journal*, May 10, 1884.

GOULD, A. PEARCE, M. S., M. B., F. R. C. S.,

Assistant Surgeon to Middlesex Hospital.

Elements of Surgical Diagnosis. In one pocket-size 12mo. volume of 589 pages. Cloth, $2.00. See *Students' Series of Manuals*, page 4.

This book will be found to be a most useful guide for the hard-worked practitioner. Mr. Gould's style is eminently clear and precise, and we can cordially recommend the manual as being the outcome of the efforts of an honest and thoroughly practical surgeon.—*The Medical News*, Jan. 24, 1885.

This is a capital little book, written by a practical man on a very practical subject. The topics are very systematically and succinctly arranged, are tersely presented, and the points of diagnosis very intelligently discussed. It will be found to be of the greatest amount of help both to teacher and student.—*Medical Record*, Feb. 28, 1885.

GIBNEY, V. P., M. D.,

Surgeon to the Orthopædic Hospital, New York, etc.

Orthopædic Surgery. For the use of Practitioners and Students. In one handsome octavo volume, profusely illustrated. *Preparing.*

DRUITT, ROBERT, M. R. C. S., etc.

The Principles and Practice of Modern Surgery. From the eighth London edition. In one 8vo. volume of 687 pages, with 432 illus. Cloth, $4; leather, $5.

ROBERTS, JOHN B., A. M., M. D.,

Lecturer on Anatomy and on Operative Surgery at the Philadelphia School of Anatomy.

The Principles and Practice of Modern Surgery. For the use of Students and Practitioners of Medicine and Surgery. In one very handsome octavo volume of about 500 pages, with many illustrations. *Preparing.*

BELLAMY, EDWARD, F. R. C. S.,

Surgeon and Lecturer on Surgery at Charing Cross Hospital, London.

Operative Surgery. *Shortly.* See *Students' Series of Manuals*, page 4.

PIRRIE'S PRINCIPLES AND PRACTICE OF SURGERY. Edited by JOHN NEILL, M. D. In one 8vo. vol. of 784 pp. with 316 illus. Cloth, $3.75.

MILLER'S PRACTICE OF SURGERY. Fourth and revised American from the last Edinburgh edition. In one large 8vo. vol. of 682 pages, with 364 illustrations. Cloth, $3.75.

SKEY'S OPERATIVE SURGERY. In one vol. 8vo. of 661 pages, with 81 woodcuts. Cloth, $3.25.

MILLER'S PRINCIPLES OF SURGERY. Fourth Americaen from the third Edinburgh edition. In one 8vo. vol. of 638 pages, with 340 illustrations. Cloth, $3.75.

ERICHSEN, JOHN E., F. R. S., F. R. C. S.,

Professor of Surgery in University College, London, etc.

The Science and Art of Surgery; Being a Treatise on Surgical Injuries, Diseases and Operations. From the eighth and enlarged English edition. In two large and beautiful octavo volumes of 2316 pages, illustrated with 984 engravings on wood. Cloth, $9; leather, raised bands, $11; half Russia, raised bands, $12.

In noticing the eighth edition of this well-known work, it would appear superfluous to say more than that it has, like its predecessors, been brought fully up to the times, and is in consequence one of the best treatises upon surgery that has ever been penned by one man. We have always regarded "The Science and Art of Surgery" as one of the best surgical text-books in the English language, and this eighth edition only confirms our previous opinion. We take great pleasure in cordially commending it to our readers.—*The Medical News*, April 11, 1885.

After being before the profession for thirty years and maintaining during that period a reputation as a leading work on surgery, there is not much to be said in the way of comment or criticism. That it still holds its own goes without saying. The author infuses into it his large experience and ripe judgment. Wedded to no school, committed to no theory, biassed by no hobby, he imparts an honest personality in his observations, and his teachings are the rulings of an impartial judge. Such men are always safe guides, and their works stand the tests of time and experience. Such an author is Erichsen, and such a work is his *Surgery*.—*Medical Record*, Feb. 21, 1885.

BRYANT, THOMAS, F. R. C. S.,

Surgeon and Lecturer on Surgery at Guy's Hospital, London.

The Practice of Surgery. Fourth American from the fourth and revised English edition. In one large and very handsome imperial octavo volume of 1040 pages, with 727 illustrations. Cloth, $6.50; leather, $7.50; half Russia, $8.00.

The fourth edition of this work is fully abreast of the times. The author handles his subjects with that degree of judgment and skill which is attained by years of patient toil and varied experience. The present edition is a thorough revision of those which preceded it, with much new matter added. His diction is so graceful and logical, and his explanations are so lucid, as to place the work among the highest order of text-books for the medical student. Almost every topic in surgery is presented in such a form as to enable the busy practitioner to review any subject in every-day practice in a short time. No time is lost with useless theories or superfluous verbiage. In short, the work is eminently clear, logical and practical.—*Chicago Medical Journal and Examiner*, April, 1886.

By the same Author.

Diseases of the Breast. In one 12mo. volume. *Preparing.* See *Series of Clinical Manuals*, page 4.

TREVES, FREDERICK, F. R. C. S.,

Hunterian Professor at the Royal College of Surgeons of England.

A Manual of Surgery. In Treatises by Various Authors. In three 12mo. volumes, containing 1866 pages, with 213 engravings. Price per volume, cloth, $2. See *Students' Series of Manuals*, page 4.

We have here the opinions of thirty-three authors, in an encyclopædic form for easy and ready reference. The three volumes embrace every variety of surgical affections likely to be met with, the paragraphs are short and pithy, and the salient points and the beginnings of new subjects are always printed in extra-heavy type, so that a person may find whatever information he may be in need of at a moment's glance. The authors have confined themselves to stating only what is really important to know, free from all diffuseness and unnecessary adornment.—*Cincinnati Lancet-Clinic*, August 21, 1886.

The hand of Mr. Treves is evident throughout in the choice, arrangement and logical sequence of the subjects. Every topic, as far as observed, is treated with a fulness of essential detail, which is somewhat surprising in view of the necessary limitations of space. Another characteristic of the work is the well-nigh universal acceptance of modern and progressive views of pathology and treatment. The entire work is conceived and executed in a scientific spirit. It is conservative without bigotry and contains the bone and marrow of modern surgery. Taking the manual in its entirety, it unquestionably fills a place in the surgeon's library which would otherwise be untenanted.—*Annals of Surgery*, Oct. 1886.

BUTLIN, HENRY T., F. R. C. S.,

Assistant Surgeon to St. Bartholomew's Hospital, London.

Diseases of the Tongue. In one 12mo. volume of 456 pages, with 8 colored plates and 3 woodcuts. Cloth, $3.50. See *Series of Clinical Manuals*, page 4.

Twenty-four excellent colored lithographs, illustrating the diseased condition of the organ have been added, which much increase the value of the book. Mr. Butlin has written a work of great merit, and the book is a valuable addition to surgical literature.—*New York Medical Journal*, July 17, 1886.

The language of the text is clear and concise. The author has aimed to state facts rather than to express opinions, and has compressed within the compass of this small volume the pathology, etiology, etc., of diseases of the tongue that are inconveniently scattered through general works on surgery and the practice of medicine. The physician and surgeon will appreciate its value as an aid and guide.—*Physician and Surgeon*, Sept. 1886.

TREVES, FREDERICK, F. R. C. S.,

Surgeon to and Lecturer on Surgery at the London Hospital.

Intestinal Obstruction. In one pocket-size 12mo. volume of 522 pages, with 60 illustrations. Limp cloth, blue edges, $2.00. See *Series of Clinical Manuals*, page 4.

A standard work on a subject that has not been so comprehensively treated by any contemporary English writer. Its completeness renders a full review difficult, since every chapter deserves minute attention, and it is impossible to do thorough justice to the author in a few paragraphs. *Intestinal Obstruction* is a work that will prove of equal value to the practitioner, the student, the pathologist, the physician and the operating surgeon.—*British Medical Journal*, Jan. 31, 1885.

BALL, CHARLES B., M. Ch., Dub., F. R. C. S. E.,

Surgeon and Teacher at Sir P. Dun's Hospital, Dublin.

Diseases of the Rectum and Anus. In one 12mo. volume of 550 pages. *Preparing.* See *Series of Clinical Manuals*, page 4.

HOLMES, TIMOTHY, M. A.,

Surgeon and Lecturer on Surgery at St. George's Hospital, London.

A System of Surgery; Theoretical and Practical. IN TREATISES BY VARIOUS AUTHORS. AMERICAN EDITION, THOROUGHLY REVISED AND RE-EDITED by JOHN H. PACKARD, M. D., Surgeon to the Episcopal and St. Joseph's Hospitals, Philadelphia, assisted by a corps of thirty-three of the most eminent American surgeons. In three large and very handsome imperial octavo volumes containing 3137 double-columned pages, with 979 illustrations on wood and 13 lithographic plates, beautifully colored. Price per set, cloth, $18.00; leather, $21.00; half Russia, $22.50. *Sold only by subscription.*

HAMILTON, FRANK H., M. D., LL. D.,

Surgeon to Bellevue Hospital, New York.

A Practical Treatise on Fractures and Dislocations. Seventh edition thoroughly revised and much improved. In one very handsome octavo volume of 998 pages, with 379 illustrations. Cloth, $5.50; leather, $6.50; very handsome half Russia, open back, $7.00.

It is about twenty-five years ago since the first edition of this great work appeared. The edition now issued is the seventh, and this fact alone is enough to testify to the excellence of it in all particulars. Books upon special subjects do not usually command extended sale, but this one is without a rival in any language. It is essentially a practical treatise, and it gathers within its covers almost everything valuable that has been written about fractures and dislocations. The principles and methods of treatment are very fully given. The book is so well known that it does not require any lengthened review. We can only say that it is still unapproached as a treatise, and that it is a proof of the zeal and industry and great ability of its distinguished author.—*The Dublin Journal of Medical Science*, Feb. 1886.

His famous treatise on *Fractures and Dislocations*, published first in 1860, is justly regarded as the best book on that subject in existence. It has now run through seven editions, and has been translated into French and German.—*Medical Record*, Aug. 14, 1886.

SMITH, STEPHEN, M. D.,

Professor of Clinical Surgery in the University of the City of New York.

The Principles and Practice of Operative Surgery. New (second) and thoroughly revised edition. In one very handsome octavo volume of 892 pages, with 1005 illustrations. Cloth, $4 00; leather, $5.00. *Just ready.*

This work is too well and too favorably known to require any words of commendation, and its merits effectually protect it from adverse criticism. It is a treatise upon the principles as well as the practice of mechanical surgery. The subject matter is brought down to the very latest period, hence we shall find the work to be a faithful exponent of the art of surgery as practised now. Stephen Smith's Operative Surgery is one of the most complete works in the English language, and is a fit companion to Malgaigne's magnificent treatise. The woodcuts are good, and are very numerous. The descriptions of operative procedures are plain, and the opinions expressed are conservative and judicious. The work reflects great credit upon the author and upon American surgical literature.—*The American Journal of the Medical Sciences*, April, 1887.

STIMSON, LEWIS A., B. A., M. D.,

Professor of Pathological Anatomy at the University of the City of New York, Surgeon and Curator to Bellevue Hospital, Surgeon to the Presbyterian Hospital, New York, etc.

A Manual of Operative Surgery. New (second) edition. In one very handsome royal 12mo. volume of 503 pages, with 342 illustrations. Cloth, $2.50. *Just ready.*

There is always room for a good book, so that while many works on operative surgery must be considered superfluous, that of Dr. Stimson has held its own. The author knows the difficult art of condensation. Thus the manual serves as a work of reference, and at the same time as a handy guide. It teaches what it professes, the steps of operations. In this edition Dr. Stimson has sought to indicate the changes that have been effected in operative methods and procedures by the antiseptic system, and has added an account of many new operations and variations in the steps of older operations. We do not desire to extol this manual above many excellent standard British publications of the same class, still we believe that it contains much that is worthy of imitation.—*British Medical Journal*, Jan. 22, 1887.

By the same Author.

A Practical Treatise on Fractures. In one very handsome octavo volume of 598 pages, with 360 beautiful illustrations. Cloth, $4.75; leather, $5.75.

The author has given to the medical profession in this treatise on fractures what is likely to become a standard work on the subject. It is certainly not surpassed by any work written in the English, or, for that matter, any other language. The author tells us in a short, concise and comprehensive manner, all that is known about his subject. There is nothing scanty or superficial about it, as in most other treatises; on the contrary, everything is thorough. The chapters on repair of fractures and their treatment show him not only to be a profound student, but likewise a practical surgeon and pathologist. His mode of treatment of the different fractures is eminently sound and practical. We consider this work one of the best on fractures; and it will be welcomed not only as a text-book, but also by the surgeon in full practice.—*N. O. Medical and Surgical Journal*, March, 1883.

MARSH, HOWARD, F. R. C. S.,

Senior Assistant Surgeon to and Lecturer on Anatomy at St. Bartholomew's Hospital, London.

Diseases of the Joints. In one 12mo. volume of 468 pages, with 64 woodcuts and a colored plate. Cloth, $2.00. See *Series of Clinical Manuals*, page 4.

PICK, T. PICKERING, F. R. C. S.,

Surgeon to and Lecturer on Surgery at St. George's Hospital, London.

Fractures and Dislocations. In one 12mo. volume of 530 pages, with 93 illustrations. Limp cloth, 2.00. See Series of Clinical Manuals, page 4.

BURNETT, CHARLES H., A. M., M. D.,

Professor of Otology in the Philadelphia Polyclinic; President of the American Otological Society.

The Ear, Its Anatomy, Physiology and Diseases. A Practical Treatise for the use of Medical Students and Practitioners. New (second) edition. In one handsome octavo volume of 580 pages, with 107 illustrations. Cloth, $4.00; leather, $5.00.

We note with pleasure the appearance of a second edition of this valuable work. When it first came out it was accepted by the profession as one of the standard works on modern aural surgery in the English language; and in his second edition Dr. Burnett has fully maintained his reputation, for the book is replete with valuable information and suggestions. The revision has been carefully carried out, and much new matter added. Dr. Burnett's work must be regarded as a very valuable contribution to aural surgery, not only on account of its comprehensiveness, but because it contains the results of the careful personal observation and experience of this eminent aural surgeon.—*London Lancet*, Feb. 21, 1885.

POLITZER, ADAM,

Imperial-Royal Prof. of Aural Therap. in the Univ. of Vienna.

A Text-Book of the Ear and its Diseases. Translated, at the Author's request, by JAMES PATTERSON CASSELLS, M. D., M. R. C. S. In one handsome octavo volume of 800 pages, with 257 original illustrations. Cloth, $5.50.

The work itself we do not hesitate to pronounce the best upon the subject of aural diseases which has ever appeared, systematic without being too diffuse on obsolete subjects, and eminently practical in every sense. The anatomical descriptions of each separate division of the ear are admirable, and profusely illustrated by woodcuts. They are followed immediately by the physiology of the section, and this again by the pathological physiology, an arrangement which serves to keep up the interest of the student by showing the direct application of what has preceded to the study of disease. The whole work can be recommended as a reliable guide to the student, and an efficient aid to the practitioner in his treatment.—*Boston Medical and Surgical Journal*, June 7, 1883.

JULER, HENRY E., F. R. C. S.,

Senior Ass't Surgeon, Royal Westminster Ophthalmic Hosp.; late Clinical Ass't, Moorfields, London.

A Handbook of Ophthalmic Science and Practice. In one handsome octavo volume of 460 pages, with 125 woodcuts, 27 colored plates, selections from the Test-types of Jaeger and Snellen, and Holmgren's Color-blindness Test. Cloth, $4.50; leather, $5.50.

This work is distinguished by the great number of colored plates which appear in it for illustrating various pathological conditions. They are very beautiful in appearance, and have been executed with great care as to accuracy. An examination of the work shows it to be one of high standing, one that will be regarded as an authority among ophthalmologists. The treatment recommended is such as the author has learned from actual experience to be the best.—*Cincinnati Medical News*, Dec. 1884.

It presents to the student concise descriptions and typical illustrations of all important eye affections, placed in juxtaposition, so as to be grasped at a glance. Beyond a doubt it is the best illustrated handbook of ophthalmic science which has ever appeared. Then, what is still better, these illustrations are nearly all original. We have examined this entire work with great care, and it represents the commonly accepted views of advanced ophthalmologists. We can most heartily commend this book to all medical students, practitioners and specialists. — *Detroit Lancet*, Jan. 1885.

NORRIS, WM. F., M. D., and OLIVER, CHAS. A., M. D.

Clin. Prof. of Ophthalmology in Univ. of Pa.

A Text-Book of Ophthalmology. In one octavo volume of about 500 pages, with illustrations. *Preparing.*

CARTER, R. BRUDENELL, & FROST, W. ADAMS, F. R. C. S., F. R. C. S.,

Ophthalmic Surgeon to and Lecturer on Ophthalmic Surgery at St. George's Hospital, London.

Assistant Ophthalmic Surgeon to and Joint Lecturer on Ophthalmic Surgery at St. George's Hospital, London.

Ophthalmic Surgery. In one 12mo. volume of about 400 pages. *Preparing.* See *Series of Clinical Manuals*, page 4.

WELLS, J. SOELBERG, F. R. C. S.,

Professor of Ophthalmology in King's College Hospital, London, etc.

A Treatise on Diseases of the Eye. New (fifth) American from the third London edition. Thoroughly revised, with copious additions, by L. WEBSTER FOX, M. D. In one large octavo volume of about 850 pages, with about 275 illustrations on wood, six colored plates, and selections from the Test-types of Jaeger and Snellen. *Preparing.*

NETTLESHIP, EDWARD, F. R. C. S.,

Ophthalmic Surg. and Lect. on Ophth. Surg. at St. Thomas' Hospital, London.

The Student's Guide to Diseases of the Eye. Second edition. With a chapter on the Detection of Color-Blindness, by WILLIAM THOMSON, M. D., Ophthalmologist to the Jefferson Medical College. In one royal 12mo. volume of 416 pages, with 138 illustrations. Cloth, $2.00.

BROWNE, EDGAR A.,

Surgeon to the Liverpool Eye and Ear Infirmary and to the Dispensary for Skin Diseases.

How to Use the Ophthalmoscope. Being Elementary Instructions in Ophthalmoscopy, arranged for the use of Students. In one small royal 12mo. volume of 116 pages, with 35 illustrations. Cloth, $1.00.

LAURENCE AND MOON'S HANDY BOOK OF OPHTHALMIC SURGERY, for the use of Practitioners. Second edition. In one octavo volume of 227 pages, with 65 illust. Cloth, $2.75.

LAWSON ON INJURIES TO THE EYE, ORBIT AND EYELIDS: Their Immediate and Remote Effects. 8 vo., 404 pp., 92 illus. Cloth, $3.50.

ROBERTS, WILLIAM, M. D.,

Lecturer on Medicine in the Manchester School of Medicine, etc.

A Practical Treatise on Urinary and Renal Diseases, including Urinary Deposits. Fourth American from the fourth London edition. In one handsome octavo volume of 609 pages, with 81 illustrations. Cloth, $3.50.

The previous editions of this book have made it so familiar to and so highly esteemed by the medical public, that little more is necessary than a mere announcement of the appearance of this, their successor. But it is pleasant to be able to say that, good as those were, this is still better. In fact, we think it may be said to be the best book in print on the subject of which it treats.—*The American Journal of the Medical Sciences.*—Jan. 1886.

The peculiar value and finish of the book are in a measure derived from its resolute maintenance of a clinical and practical character. It is an unrivalled exposition of everything which relates directly or indirectly to the diagnosis, prognosis and treatment of urinary diseases, and possesses a completeness not found elsewhere in our language in its account of the different affections.—*The Manchester Medical Chronicle*, July, 1885.

PURDY, CHARLES W., M. D.

Bright's Disease and Allied Disorders. In one octavo volume of 288 pages, with illustrations. Cloth, $2. *Just ready.*

The object of this work is to "furnish a systematic, practical and concise description of the pathology and treatment of the chief organic diseases of the kidney associated with albuminuria, which shall represent the most recent advances in our knowledge on these subjects;" and this definition of the object is a fair description of the book. The work is a useful one, giving in a short space the theories, facts and treatments, and going more fully into their later developments. On treatment the writer is particularly strong, steering clear of generalities, and seldom omitting, what text-books usually do, the unimportant items which are all important to the general practitioner.—*The Manchester Medical Chronicle*, Oct., 1886.

MORRIS, HENRY, M. B., F. R. C. S.,

Surgeon to and Lecturer on Surgery at Middlesex Hospital, London.

Surgical Diseases of the Kidney. In one 12mo. volume of 554 pages, with 40 woodcuts, and 6 colored plates. Limp cloth, $2.25. See *Series of Clinical Manuals*, page 4.

In this manual we have a distinct addition to surgical literature, which gives information not elsewhere to be met with in a single work. Such a book was distinctly required, and Mr. Morris has very diligently and ably performed the task he took in hand. It is a full and trustworthy book of reference, both for students and practitioners in search of guidance. The illustrations in the text and the chromo-lithographs are beautifully executed.—*The London Lancet*, Feb. 26, 1886.

LUCAS, CLEMENT, M. B., B. S., F. R. C. S.,

Senior Assistant Surgeon to Guy's Hospital, London.

Diseases of the Urethra. In one 12mo. volume. *Preparing.* See *Series of Clinical Manuals*, page 4.

THOMPSON, SIR HENRY,

Surgeon and Professor of Clinical Surgery to University College Hospital, London.

Lectures on Diseases of the Urinary Organs. Second American from the third English edition. In one 8vo. volume of 203 pp., with 25 illustrations. Cloth, $2.25.

By the Same Author.

On the Pathology and Treatment of Stricture of the Urethra and Urinary Fistulæ. From the third English edition. In one octavo volume of 359 pages, with 47 cuts and 3 plates. Cloth, $3.50.

THE AMERICAN SYSTEM OF DENTISTRY.

In Treatises by Various Authors. Edited by Wilbur F. Litch, M. D., D. D. S., Professor of Prosthetic Dentistry, Materia Medica and Therapeutics in the Pennsylvania College of Dental Surgery. In three very handsome octavo volumes of about 1000 pages each, richly illustrated. Per volume, cloth, $6; leather, $7; half Morocco, gilt top, $8. Volume I., containing 1015 pages, with 6 plates and 537 woodcuts, *just ready.* *For sale by subscription only.*

As an encyclopædia of Dentistry it has no superior. It should form a part of every dentist's library, as the information it contains is of the greatest value to all engaged in the practice of dentistry.—*American Journal of Dental Science*, September, 1886.

A grand system, big enough and good enough and handsome enough for a monument (which doubtless it is), to mark an epoch in the history of dentistry. Dentists will be satisfied with it and proud of it—they must. It is sure to be precisely what the student needs to put him and keep him in the right track, while the profession at large will receive incalculable benefit from it.—*Odontographic Journal*, Jan. 1887.

COLEMAN, A., L. R. C. P., F. R. C. S., Exam. L. D. S.,

Senior Dent. Surg. and Lect. on Dent. Surg. at St. Bartholomew's Hosp. and the Dent. Hosp., London.

A Manual of Dental Surgery and Pathology. Thoroughly revised and adapted to the use of American Students, by Thomas C. Stellwagen, M. A., M. D., D. D. S., Prof. of Physiology at the Philadelphia Dental College. In one handsome octavo volume of 412 pages, with 331 illustrations. Cloth, $3.25.

ESMARCH, Dr. FRIEDRICH,

Professor of Surgery at the University of Kiel, etc.

Early Aid in Injuries and Accidents. Five Ambulance Lectures. Translated by H. R. H. Princess Christian. In one handsome small 12mo. volume of 109 pages, with 24 illustrations. Cloth, 75 cents.

BASHAM ON RENAL DISEASES: A Clinical Guide to their Diagnosis and Treatment. In one 12mo. vol. of 304 pages, with 21 illustrations. Cloth, $2.00.

GROSS, SAMUEL W., A. M., M. D., LL. D.,

Professor of the Principles of Surgery and of Clinical Surgery in the Jefferson Medical College of Phila.

A Practical Treatise on Impotence, Sterility, and Allied Disorders of the Male Sexual Organs. New (third) edition, thoroughly revised. In one very handsome octavo volume of 163 pages, with 16 illustrations. Cloth, $1.50. *Just ready.*

FROM THE PREFACE TO THE NEW EDITION.

The rapid exhaustion of two large editions of this work, the favorable comments which it has received from the periodical press, its translation into the Russian language, and the fact that it has been out of print for several months, constitute valid evidence that it has filled the void for which it was originally designed. My aim has been to supply in a compact form practical and strictly scientific information, especially adapted to the wants of the general practitioner, in regard to a class of common and grave disorders, upon the correction of which so much of human happiness depends.

BUMSTEAD, F. J., M. D., LL. D., *and* *TAYLOR, R. W., A. M., M. D.,*

Late Professor of Venereal Diseases at the College of Physicians and Surgeons, New York, etc.

Surgeon to Charity Hospital, New York, Prof. of Venereal and Skin Diseases in the University of Vermont, Pres. of the Am. Dermatological Ass'n.

The Pathology and Treatment of Venereal Diseases. Including the results of recent investigations upon the subject. Fifth edition, revised and largely rewritten, by Dr. Taylor. In one large and handsome octavo volume of 898 pages with 139 illustrations, and thirteen chromo-lithographic figures. Cloth, $4.75; leather, $5.75; very handsome half Russia, $6.25.

It is a splendid record of honest labor, wide research, just comparison, careful scrutiny and original experience, which will always be held as a high credit to American medical literature. This is not only the best work in the English language upon the subjects of which it treats, but also one which has no equal in other tongues for its clear, comprehensive and practical handling of its themes.—*American Journal of the Medical Sciences,* Jan, 1884.

It is certainly the best single treatise on venereal in our own, and probably the best in any language.—*Boston Medical and Surgical Journal,* April 3, 1884.

The character of this standard work is so well known that it would be superfluous here to pass in review its general or special points of excellence. The verdict of the profession has been passed; it has been accepted as the most thorough and complete exposition of the pathology and treatment of venereal diseases in the language. Admirable as a model of clear description, an exponent of sound pathological doctrine, and a guide for rational and successful treatment, it is an ornament to the medical literature of this country. The additions made to the present edition are eminently judicious, from the standpoint of practical utility.—*Journal of Cutaneous and Venereal Diseases,* Jan. 1884.

CORNIL, V.,

Professor to the Faculty of Medicine of Paris, and Physician to the Loureine Hospital.

Syphilis, its Morbid Anatomy, Diagnosis and Treatment. Specially revised by the Author, and translated with notes and additions by J. HENRY C. SIMES, M. D., Demonstrator of Pathological Histology in the University of Pennsylvania, and J. WILLIAM WHITE, M. D., Lecturer on Venereal Diseases and Demonstrator of Surgery in the University of Pennsylvania. In one handsome octavo volume of 461 pages, with 84 very beautiful illustrations. Cloth, $3.75.

The anatomical and histological characters of the hard and soft sore are admirably described. The multiform cutaneous manifestations of the disease are dealt with histologically in a masterly way, as we should indeed expect them to be, and the accompanying illustrations are executed carefully and well. The various nervous lesions which are the recognized outcome of the syphilitic dyscrasia are treated with care and consideration. Syphilitic epilepsy, paralysis, cerebral syphilis and locomotor ataxia are subjects full of interest; and nowhere in the whole volume is the clinical experience of the author or the wide acquaintance of the translators with medical literature more evident. The anatomy, the histology, the pathology and the clinical features of syphilis are represented in this work in their best, most practical and most instructive form, and no one will rise from its perusal without the feeling that his grasp of the wide and important subject on which it treats is a stronger and surer one.—*The London Practitioner,* Jan. 1882.

HUTCHINSON, JONATHAN, F. R. S., F. R. C. S.,

Consulting Surgeon to the London Hospital.

Syphilis. In one 12mo. volume. *Shortly.* See *Series of Clinical Manuals,* page

GROSS, S. D., M. D., LL. D., D. C. L., etc.

A Practical Treatise on the Diseases, Injuries and Malformations of the Urinary Bladder, the Prostate Gland and the Urethra. Third edition, thoroughly revised by SAMUEL W. GROSS, M. D. In one octavo volume of 574 pages, with 170 illustrations. Cloth, $4.50.

CULLERIER, A., & BUMSTEAD, F. J., M.D., LL.D.,

Surgeon to the Hôpital du Midi. *Late Professor of Venereal Diseases in the College of Physicians and Surgeons, New York.*

An Atlas of Venereal Diseases. Translated and edited by FREEMAN J. BUMSTEAD, M. D. In one imperial 4to. volume of 328 pages, double-columns, with 26 plates, containing about 150 figures, beautifully colored, many of them the size of life. Strongly bound in cloth, $17.00. A specimen of the plates and text sent by mail, on receipt of 25 cts.

HILL ON SYPHILIS AND LOCAL CONTAGIOUS DISORDERS. In one 8vo vol. of 479 p. Cloth, $3.25.

LEE'S LECTURES ON SYPHILIS AND SOME FORMS OF LOCAL DISEASE AFFECTING PRINCIPALLY THE ORGANS OF GENERATION. In one 8vo. vol. of 246 pages. Cloth, $2.25.

HYDE, J. NEVINS, A. M., M. D.,

Professor of Dermatology and Venereal Diseases in Rush Medical College, Chicago.

A Practical Treatise on Diseases of the Skin. For the use of Students and Practitioners. In one handsome octavo volume of 570 pages, with 66 beautiful and elaborate illustrations. Cloth, $4.25; leather, $5.25.

The author has given the student and practitioner a work admirably adapted to the wants of each. We can heartily commend the book as a valuable addition to our literature and a reliable guide to students and practitioners in their studies and practice.—*Am. Journ. of Med. Sci.*, July, 1883.

The aim of the author has been to present to his readers a work not only expounding the most modern conceptions of his subject, but presenting what is of standard value. He has more especially devoted its pages to the treatment of disease, and by his detailed descriptions of therapeutic measures has adapted them to the needs of the physician in active practice. In dealing with these questions the author leaves nothing to the presumed knowledge of the reader, but enters thoroughly into the most minute description, so that one is not only told what should be done under given conditions but how to do it as well. It is therefore in the best sense "a practical treatise." That it is comprehensive, a glance at the index will show.—*Maryland Medical Journal*, July 7, 1883.

Professor Hyde has long been known as one of the most intelligent and enthusiastic representatives of dermatology in the west. His numerous contributions to the literature of this specialty have gained for him a favorable recognition as a careful, conscientious and original observer. The remarkable advances made in our knowledge of diseases of the skin, especially from the standpoint of pathological histology and improved methods of treatment, necessitate a revision of the older text-books at short intervals in order to bring them up to the standard demanded by the march of science. This last contribution of Dr. Hyde is an effort in this direction. He has attempted, as he informs us, the task of presenting in a condensed form the results of the latest observation and experience. A careful examination of the work convinces us that he has accomplished his task with painstaking fidelity and with a creditable result.—*Journal of Cutaneous and Venereal Diseases*, June, 1883.

Prof. Hyde has given to the profession a valuable and comprehensive work upon this special subject—exposing the etiology, symptomatology and treatment of diseases of the skin in a concise and thorough manner. The book is a valuable one for the student and practitioner, containing all the latest progress made in dermatology, and will, without doubt, attain the end expected by its author—to make the general practitioner thoroughly informed in regard to the treatment of cutaneous diseases; and it will prove a valuable book of reference to the specialist.—*New Orleans Medical and Surgical Journal*, April, 1883.

The several diseases are described very concisely, but at the same time with unusual clearness. The treatment is given in the simplest manner and apparently with great honesty. It is a good book, remarkably adapted to the needs of those for whom it was written. It should be at once placed in the library of every general practitioner.—*Detroit Lancet*, April, 1883.

FOX, T., M.D., F.R.C.P., and FOX, T.C., B.A., M.R.C.S.,

Physician to the Department for Skin Diseases, University College Hospital, London.

Physician for Diseases of the Skin to the Westminster Hospital, London.

An Epitome of Skin Diseases. With Formulæ. For Students and Practitioners. Third edition, revised and enlarged. In one very handsome 12mo. volume of 238 pages. Cloth, $1.25.

The third edition of this convenient handbook calls for notice owing to the revision and expansion which it has undergone. The arrangement of skin diseases in alphabetical order, which is the method of classification adopted in this work, becomes a positive advantage to the student. The book is one which we can strongly recommend, not only to students but also to practitioners who require a compendious summary of the present state of dermatology.—*British Medical Journal*, July 2, 1883.

We cordially recommend Fox's *Epitome* to those whose time is limited and who wish a handy manual to lie upon the table for instant reference. Its alphabetical arrangement is suited to this use, for all one has to know is the name of the disease, and here are its description and the appropriate treatment at hand and ready for instant application. The present edition has been very carefully revised and a number of new diseases are described, while most of the recent additions to dermal therapeutics find mention, and the formulary at the end of the book has been considerably augmented.—*The Medical News*, December, 1883.

MORRIS, MALCOLM, F. R. C. S.,

Joint Lecturer on Dermatology at St. Mary's Hospital Medical School, London.

Skin Diseases; Including their Definitions, Symptoms, Diagnosis, Prognosis, Morbid Anatomy and Treatment. A Manual for Students and Practitioners. In one 12mo. volume of 316 pages, with illustrations. Cloth, $1.75.

To physicians who would like to know something about skin diseases, so that when a patient presents himself for relief they can make a correct diagnosis and prescribe a rational treatment, we unhesitatingly recommend this little book of Dr. Morris. The affections of the skin are described in a terse, lucid manner, and their several characteristics so plainly set forth that diagnosis will be easy. The treatment in each case is such as the experience of the most eminent dermatologists advises.—*Cincinnati Medical News*, April, 1880.

This is emphatically a learner's book; for we can safely say, that in the whole range of medical literature there is no book of a like scope which for clearness of expression and methodical arrangement is better adapted to promote a rational conception of dermatology—a branch confessedly difficult and perplexing to the beginner.—*St. Louis Courier of Medicine*, April, 1880.

The writer has certainly given in a small compass a large amount of well-compiled information, and his little book compares favorably with any other which has emanated from England, while in many points he has emancipated himself from the stubbornly adhered to errors of others of his countrymen. There is certainly excellent material in the book which will well repay perusal.—*Boston Med. and Surg. Journ.*, March, 1880.

WILSON, ERASMUS, F. R. S.

The Student's Book of Cutaneous Medicine and Diseases of the Skin. In one handsome small octavo volume of 535 pages. Cloth, $3.50.

HILLIER, THOMAS, M. D.,

Physician to the Skin Department of University College, London.

Handbook of Skin Diseases; for Students and Practitioners. Second American edition. In one 12mo. volume of 353 pages, with plates. Cloth, $2.25.

The American Systems of Gynecology and Obstetrics.

Systems of Gynecology and Obstetrics, in Treatises by American Authors. Gynecology edited by MATTHEW D. MANN, M. D., Professor of Obstetrics and Gynecology in the Medical Department of the University of Buffalo, and Obstetrics edited by BARTON COOKE HIRST, M. D., Obstetrician to the Maternity Hospital, Philadelphia. In four very handsome octavo volumes of about 900 pages each, fully illustrated by wood engravings and colored plates. Volume I., *shortly.*

LIST OF CONTRIBUTORS.

WILLIAM H. BAKER, M. D.,
FORDYCE BARKER, M. D.,
ROBERT BATTEY, M. D.,
SAMUEL C. BUSEY, M. D.,
JAMES C. CAMERON, M. D.,
HENRY C. COE, M. D.,
E. C. DUDLEY, M. D.,
GEORGE J. ENGELMANN, M. D.,
HAROLD C. ERNST, M. D.,
HENRY J. GARRIGUES, M. D.,
WILLIAM GOODELL, M. D.,
EGBERT H. GRANDIN, M. D.,
CHARLES M. GREEN, M. D.,
SAMUEL W. GROSS, M. D.,
ROBERT P. HARRIS, M. D.,
JAMES B. HUNTER, M. D.,
A. REEVES JACKSON, M. D.,
EDWARD W. JENKS, M. D.,
JOSEPH TABER JOHNSON, M. D.,
WILLIAM T. LUSK, M. D.,
H. NEWELL MARTIN, F. R. S., M. D., D.Sc., M. A.,
RICHARD B. MAURY, M. D.,
PAUL F. MUNDE, M. D.,
C. D. PALMER, M. D.,
THEOPHILUS PARVIN, M. D.,
R. A. F. PENROSE, M. D.,
WILLIAM M. POLK, M. D.,
THADDEUS A. REAMY, M. D.,
J. C. REEVE, M. D.,
WILLIAM L. RICHARDSON, M. D.,
A. D. ROCKWELL, M. D.,
ALEXANDER J. C. SKENE, M. D.,
J. LEWIS SMITH, M. D.,
R. STANSBURY SUTTON, M. D.,
T. GAILLARD THOMAS, M. D.,
ELY VAN DE WARKER, M. D.,
W. GILL WYLIE, M. D.

THOMAS, T. GAILLARD, M. D.,

Professor of Diseases of Women in the College of Physicians and Surgeons, N. Y.

A Practical Treatise on the Diseases of Women. Fifth edition, thoroughly revised and rewritten. In one large and handsome octavo volume of 810 pages, with 266 illustrations. Cloth, $5.00; leather, $6.00; very handsome half Russia, raised bands, $6.50.

The words which follow "fifth edition" are in this case no mere formal announcement. The alterations and additions which have been made are both numerous and important. The attraction and the permanent character of this book lie in the clearness and truth of the clinical descriptions of diseases; the fertility of the author in therapeutic resources and the fulness with which the details of treatment are described; the definite character of the teaching; and last, but not least, the evident candor which pervades it. We would also particularize the fulness with which the history of the subject is gone into, which makes the book additionally interesting and gives it value as a work of reference.—*London Medical Times and Gazette*, July 30, 1881.

The determination of the author to keep his book foremost in the rank of works on gynæcology is most gratifying. Recognizing the fact that this can only be accomplished by frequent and thorough revision, he has spared no pains to make the present edition more desirable even than the previous one. As a book of reference for the busy practitioner it is unequalled.—*Boston Medical and Surgical Journal*, April 7, 1880.

It has been enlarged and carefully revised. It is a condensed encyclopædia of gynæcological medicine. The style of arrangement, the masterly manner in which each subject is treated, and the honest convictions derived from probably the largest clinical experience in that specialty of any in this country, all serve to commend it in the highest terms to the practitioner.—*Nashville Jour. of Med. and Surg.*, Jan. 1881.

That the previous editions of the treatise of Dr. Thomas were thought worthy of translation into German, French, Italian and Spanish, is enough to give it the stamp of genuine merit. At home it has made its way into the library of every obstetrician and gynæcologist as a safe guide to practice. No small number of additions have been made to the present edition to make it correspond to recent improvements in treatment.—*Pacific Medical and Surgical Journal*, Jan. 1881.

EDIS, ARTHUR W., M. D., Lond., F. R. C. P., M. R. C. S.,

Assist. Obstetric Physician to Middlesex Hospital, late Physician to British Lying-in Hospital.

The Diseases of Women. Including their Pathology, Causation, Symptoms, Diagnosis and Treatment. A Manual for Students and Practitioners. In one handsome octavo volume of 576 pages, with 148 illustrations. Cloth, $3.00; leather, $4.00.

It is a pleasure to read a book so thoroughly good as this one. The special qualities which are conspicuous are thoroughness in covering the whole ground, clearness of description and conciseness of statement. Another marked feature of the book is the attention paid to the details of many minor surgical operations and procedures, as, for instance, the use of tents, application of leeches, and use of hot water injections. These are among the more common methods of treatment, and yet very little is said about them in many of the text-books. The book is one to be warmly recommended especially to students and general practitioners, who need a concise but complete *résumé* of the whole subject. Specialists, too, will find many useful hints in its pages.—*Boston Med. and Surg. Journ.*, March 2, 1882.

The greatest pains have been taken with the sections relating to treatment. A liberal selection of remedies is given for each morbid condition, the strength, mode of application and other details being fully explained. The descriptions of gynæcological manipulations and operations are full, clear and practical. Much care has also been bestowed on the parts of the book which deal with diagnosis—we note especially the pages dealing with the differentiation, one from another, of the different kinds of abdominal tumors. The practitioner will therefore find in this book the kind of knowledge he most needs in his daily work, and he will be pleased with the clearness and fulness of the information there given.—*The Practitioner*, Feb. 1882.

BARNES, ROBERT, M. D., F. R. C. P.,

Obstetric Physician to St. Thomas' Hospital, London, etc.

A Clinical Exposition of the Medical and Surgical Diseases of Women. In one handsome octavo volume, with numerous illustrations. New edition. *Preparing.*

WEST, CHARLES, M. D.

Lectures on the Diseases of Women. Third American from the third London edition. In one octavo volume of 543 pages. Cloth, $3.75; leather, $4.75.

EMMET, THOMAS ADDIS, M. D., LL. D.,

Surgeon to the Woman's Hospital, New York, etc.

The Principles and Practice of Gynæcology; For the use of Students and Practitioners of Medicine. New (third) edition, thoroughly revised. In one large and very handsome octavo volume of 880 pages, with 150 illustrations. Cloth, $5; leather, $6; very handsome half Russia, raised bands, $6.50.

We are in doubt whether to congratulate the author more than the profession upon the appearance of the third edition of this well-known work. Embodying, as it does, the life-long experience of one who has conspicuously distinguished himself as a bold and successful operator, and who has devoted so much attention to the specialty, we feel sure the profession will not fail to appreciate the privilege thus offered them of perusing the views and practice of the author. His earnestness of purpose and conscientiousness are manifest. He gives not only his individual experience but endeavors to represent the actual state of gynæcological science and art.—*British Medical Journal*, May 16, 1885.

No jot or tittle of the high praise bestowed upon the first edition is abated. It is still a book of marked personality, one based upon large clinical experience, containing large and valuable additions to our knowledge, evidently written not only with honesty of purpose, but with a conscientious sense of responsibility, and a book that is at once a credit to its author and to American medical literature. We repeat that it is a book to be studied, and one that is indispensable to every practitioner giving any attention to gynæcology.—*American Journal of the Medical Sciences*, April, 1885.

The time has passed when Emmet's *Gynæcology* was to be regarded as a book for a single country or for a single generation. It has always been his aim to popularize gynæcology, to bring it within easy reach of the general practitioner. The originality of the ideas, aside from the perfect confidence which we feel in the author's statements, compels our admiration and respect. We may well take an honest pride in Dr. Emmet's work and feel that his book can hold its own against the criticism of two continents. It represents all that is most earnest and most thoughtful in American gynæcology. Emmet's work will continue to reflect the individuality, the sterling integrity and the kindly heart of its honored author long after smaller books have been forgotten.—*American Journal of Obstetrics*, May, 1885.

DUNCAN, J. MATTHEWS, M.D., LL. D., F. R. S. E., etc.

Clinical Lectures on the Diseases of Women; Delivered in Saint Bartholomew's Hospital. In one handsome octavo volume of 175 pages. Cloth, $1.50.

They are in every way worthy of their author; indeed, we look upon them as among the most valuable of his contributions. They are all upon matters of great interest to the general practitioner. Some of them deal with subjects that are not, as a rule, adequately handled in the text-books; others of them, while bearing upon topics that are usually treated of at length in such works, yet bear such a stamp of individuality that they deserve to be widely read.—*N. Y. Medical Journal*, March, 1880.

MAY, CHARLES H., M. D.

Late House Surgeon to Mount Sinai Hospital, New York.

A Manual of the Diseases of Women. Being a concise and systematic exposition of the theory and practice of gynæcology. In one 12mo. volume of 342 pages. Cloth, $1.75.

Medical students will find this work adapted to their wants. Also practitioners of medicine will find it exceedingly convenient to consult for the purpose of refreshing their minds upon the leading points of a gynæcological subject. By systematic condensation, the omission of disputed questions, and the presentation only of accepted views, it constitutes a very satisfactory exposition of the leading principles of gynæcology as they are understood at the present time.—*Cincinnati Medical News*, Nov. 1885.

HODGE, HUGH L., M. D.,

Emeritus Professor of Obstetrics, etc., in the University of Pennsylvania.

On Diseases Peculiar to Women; Including Displacements of the Uterus. Second edition, revised and enlarged. In one beautifully printed octavo volume of 519 pages, with original illustrations. Cloth, $4.50.

By the Same Author.

The Principles and Practice of Obstetrics. Illustrated with large lithographic plates containing 159 figures from original photographs, and with numerous woodcuts. In one large quarto volume of 542 double-columned pages. Strongly bound in cloth, $14.00. Specimens of the plates and letter-press will be forwarded to any address, free by mail, on receipt of six cents in postage stamps.

RAMSBOTHAM, FRANCIS H., M. D.

The Principles and Practice of Obstetric Medicine and Surgery; In reference to the Process of Parturition. A new and enlarged edition, thoroughly revised by the Author. With additions by W. V. KEATING, M. D., Professor of Obstetrics, etc., in the Jefferson Medical College of Philadelphia. In one large and handsome imperial octavo volume of 640 pages, with 64 full-page plates and 43 woodcuts in the text, containing in all nearly 200 beautiful figures. Strongly bound in leather, with raised bands, $7.

WINCKEL, F.

A Complete Treatise on the Pathology and Treatment of Childbed, For Students and Practitioners. Translated, with the consent of the Author, from the second German edition, by J. R. CHADWICK, M. D. Octavo 484 pages. Cloth, $4.00.

ASHWELL'S PRACTICAL TREATISE ON THE DISEASES PECULIAR TO WOMEN. Third American from the third and revised London edition. In one 8vo. vol., pp. 520. Cloth, $3.50.

CHURCHILL ON THE PUERPERAL FEVER AND OTHER DISEASES PECULIAR TO WOMEN. In one 8vo. vol. of 464 pages. Cloth, $2.50.

MEIGS ON THE NATURE, SIGNS AND TREATMENT OF CHILDBED FEVER. In one 8vo. volume of 346 pages. Cloth, $2.00.

PARVIN, THEOPHILUS, M. D., LL. D.,

Prof. of Obstetrics and the Diseases of Women and Children in Jefferson Med. Coll., Phila.

The Science and Art of Obstetrics. In one handsome 8vo. volume of 697 pages, with 214 engravings and a colored plate. Cloth, $4.25; leather, $5.25. *Just ready.*

There is not in the language a treatise on the subject which so completely and intelligently gleans the whole field of obstetric literature, giving the reader the winnowed wheat in concise and well-jointed phrase, in language of exceptional purity and strength. A thorough student always, a close observer from a practising standpoint for a third of a century, and a critical teacher for a score of years, Prof. Parvin has conscientiously devoted the accomplishments of his culture to the preparation of his book, and his readers will have the benefit of a work full of the riches of an erudite author inspired with his labor, and wisely wedded to the truth therein as he sees it. The arrangement of the matter of this work is unique and exceedingly favorable for an agreeable unfolding of the science and art of obstetrics. This new book is the easy superior of any single work among its predecessors for the student or practitioner seeking the best thought of the day in this department of medicine.—*The American Practitioner and News*, April 2, 1887.

BARNES, ROBERT, M. D., and FANCOURT, M. D.,

Phys. to the General Lying-in Hosp., Lond. *Obstetric Phys. to St. Thomas' Hosp., Lond.*

A System of Obstetric Medicine and Surgery, Theoretical and Clinical. For the Student and the Practitioner. The Section on Embryology contributed by Prof. Milnes Marshall. In one handsome octavo volume of 872 pages, with 231 illustrations. Cloth, $5; leather, $6.

This system will be eagerly sought for, not only on account of its intrinsic merit, but also because the reputation which the elder Barnes, in particular, has secured, carries with it the conviction that any book emanating from him is necessarily sound in teaching and conservative in practice. It is indeed eminently fitting that a man who has done so much towards systematizing the obstetric art, who for so many years has been widely known as a capable teacher and trusted accoucheur, should embody within a single treatise the system which he has taught and in practice tested, and which is the outcome of a lifetime of earnest labor, careful observation and deep study. The result of this arrangement is the production of a work which rises above criticism and which in no respect need yield the palm to any obstetrical treatise hitherto published.—*American Journal of Obstetrics*, Feb. 1886.

PLAYFAIR, W. S., M. D., F. R. C. P.,

Professor of Obstetric Medicine in King's College, London, etc.

A Treatise on the Science and Practice of Midwifery. New (fourth) American, from the fifth English edition. Edited, with additions, by ROBERT P. HARRIS, M. D. In one handsome octavo volume of 654 pages, with 3 plates and 201 engravings. Cloth, $4; leather, $5; half Russia, $5.50.

This still remains a favorite in America, not only because the author is recognized as a safe guide and eminently progressive man, but also as sparing no effort to make each successive edition a faithful mirror of the latest and best practice. A work so frequently noticed as the present requires no further review. We believe that this edition is simply the forerunner of many others, and that the demand will keep pace with the supply.—*American Journal of Obstetrics*, Nov. 1885.

Since its first publication, only eight years ago, it has rapidly become the favorite text-book, to the practical exclusion of all others. A large measure of its popularity is due to the clear and easy style in which it is written. Few text-books for students have very much to boast of in this respect.—*Medical Record.*

KING, A. F. A., M. D.,

Professor of Obstetrics and Diseases of Women in the Medical Department of the Columbian University, Washington, D. C., and in the University of Vermont, etc.

A Manual of Obstetrics. New (third) edition. In one very handsome 12mo. volume of 376 pages, with 102 illustrations. Cloth, $2.25. *Just ready.*

This little manual, certainly the best of its kind, fully deserves the popularity which has made a third edition necessary. Clear, practical, concise, its teachings are so fully abreast with recent advances in obstetric science that but few points can be criticised.—*American Journal of Obstetrics*, March, 1887.

This volume deserves commendation. It is not bulky—it is concise. The chapters are divided with sub-headings, which aid materially in the finding of any particular subject, and the definitions are clear and explicit. It fulfils its purpose admirably, and we know of no better work to place in the student's hands. The illustrations are good.—*Archives of Gynecology*, January, 1887.

BARKER, FORDYCE, A. M., M. D., LL. D. Edin.,

Clinical Professor of Midwifery and the Diseases of Women in the Bellevue Hospital Medical College, New York, Honorary Fellow of the Obstetrical Societies of London and Edinburgh, etc., etc.

Obstetrical and Clinical Essays. In one handsome 12mo. volume of about 300 pages. *Preparing.*

BARNES, FANCOURT, M. D.,

Obstetric Physician to St. Thomas' Hospital, London.

A Manual of Midwifery for Midwives and Medical Students. In one royal 12mo. volume of 197 pages, with 50 illustrations. Cloth, $1.25.

PARRY, JOHN S., M. D.,

Obstetrician to the Philadelphia Hospital, Vice-President of the Obstet. Society of Philadelphia.

Extra-Uterine Pregnancy: Its Clinical History, Diagnosis, Prognosis and Treatment. In one handsome octavo volume of 272 pages. Cloth, $2.50.

TANNER ON PREGNANCY. Octavo, 490 pages, 4 colored plates, 16 cuts. Cloth, $4.25.

LEISHMAN, WILLIAM, M. D.,

Regius Professor of Midwifery in the University of Glasgow, etc.

A System of Midwifery, Including the Diseases of Pregnancy and the Puerperal State. Third American edition, revised by the Author, with additions by JOHN S. PARRY, M. D., Obstetrician to the Philadelphia Hospital, etc. In one large and very handsome octavo volume of 740 pages, with 205 illustrations. Cloth, $4.50; leather, $5.50; very handsome half Russia, raised bands, $6.00.

The author is broad in his teachings, and discusses briefly the comparative anatomy of the pelvis and the mobility of the pelvic articulations. The second chapter is devoted especially to the study of the pelvis, while in the third the female organs of generation are introduced. The structure and development of the ovum are admirably described. Then follow chapters upon the various subjects embraced in the study of midwifery. The descriptions throughout the work are plain and pleasing. It is sufficient to state that in this, the last edition of this well-known work, every recent advancement in this field has been brought forward.—*Physician and Surgeon*, Jan. 1880.

To the American student the work before us must prove admirably adapted. Complete in all its parts, essentially modern in its teachings, and with demonstrations noted for clearness and precision, it will gain in favor and be recognized as a work of standard merit. The work cannot fail to be popular and is cordially recommended.—*N. O. Med. and Surg. Journ.*, March, 1880.

It has been well and carefully written. The views of the author are broad and liberal, and indicate a well-balanced judgment and matured mind. We observe no spirit of dogmatism, but the earnest teaching of the thoughtful observer and lover of true science. Take the volume as a whole, and it has few equals.—*Maryland Medical Journal*, Feb. 1880.

LANDIS, HENRY G., A. M., M. D.,

Professor of Obstetrics and the Diseases of Women in Starling Medical College, Columbus, O.

The Management of Labor, and of the Lying-in Period. In one handsome 12mo. volume of 334 pages, with 28 illustrations. Cloth, $1.75. *Just ready.*

The author has designed to place in the hands of the young practitioner a book in which he can find necessary information in an instant. As far as we can see, nothing is omitted. The advice is sound, and the proceedures are safe and practical. *Centralblatt fur Gynakologie*, December 4, 1886.

This is a book we can heartily recommend. The author goes much more practically into the details of the management of labor than most text-books, and is so readable throughout as to tempt any one who should happen to commence the book to read it through. The author presupposes a theoretical knowledge of obstetrics, and has consistently excluded from this little work everything that is not of practical use in the lying-in room. We think that if it is as widely read as it deserves, it will do much to improve obstetric practice in general.—*New Orleans Medical and Surgical Journal*, Mar. 1886.

SMITH, J. LEWIS, M. D.,

Clinical Professor of Diseases of Children in the Bellevue Hospital Medical College, N. Y.

A Treatise on the Diseases of Infancy and Childhood. New (sixth) edition, thoroughly revised and rewritten. In one handsome octavo volume of 867 pages, with 40 illustrations. Cloth, $4.50; leather, $5.50; half Russia, $6.00. *Just ready.*

Rarely does a pleasanter task fall to the lot of the bibliographer than to announce the appearance of a new edition of a medical classic like Prof. J. Lewis Smith's *Treatise on the Diseases of Infancy and Childhood*. For years it has stood high in the confidence of the profession, and with the additions and alterations now made it may be said to be the best book in the language on the subject of which it treats. An examination of the text fully sustains the claims made in the preface, that "in preparing the sixth edition the author has revised the text to such an extent that a considerable part of the book may be considered new." If the young practitioner proposes to place in his library but one book on the diseases of children, we would unhesitatingly say, let that book be the one which is the subject of this notice.—*The American Journal of the Medical Sciences*, April, 1886.

No better work on children's diseases could be placed in the hands of the student, containing, as it does, a very complete account of the symptoms and pathology of the diseases of early life, and possessing the further advantage, in which it stands alone amongst other works on its subject, of recommending treatment in accordance with the most recent therapeutical views.—*British and Foreign Medico-Chirurgical Review.*

It is a pleasure to the busy practitioner—interested in the advancement of his profession—to meet, fresh from the hands of its author, a medical classic such as Smith on Diseases of Children. Those familiar with former editions of the work will readily recognize the painstaking with which this revision has been made. Many of the articles have been entirely rewritten. The whole work is enriched with a research and reasoning which plainly show that the author has spared neither time nor labor in bringing it to its present approach towards perfection. The extended table of contents and the well-prepared index will enable the busy practitioner to reach readily and quickly for reference the various subjects treated of in the body of the work, and even those who are familiar with former editions will find the improvements in the present richly worth the cost of the work.—*Atlanta Medical and Surgical Journal*, Dec. 1886.

OWEN, EDMUND, M. B., F. R. C. S.,

Surgeon to the Children's Hospital, Great Ormond St., London.

Surgical Diseases of Children. In one 12mo. volume of 525 pages, with 4 chromo-lithographic plates and 85 woodcuts. *Just ready.* Cloth, $2. See *Series of Clinical Manuals*, page 4.

One is immediately struck on reading this book with its agreeable style and the evidence it everywhere presents of the practical familiarity of its author with his subject. The book may be honestly recommended to both students and practitioners. It is full of sound information, pleasantly given.—*Annals of Surgery*, May, 1886.

WEST, CHARLES, M. D.,

Physician to the Hospital for Sick Children, London, etc.

On Some Disorders of the Nervous System in Childhood. In one small 12mo. volume of 127 pages. Cloth, $1.00.

WEST'S LECTURES ON THE DISEASES OF INFANCY AND CHILDHOOD. In one octavo vol.

CONDIE'S PRACTICAL TREATISE ON THE DISEASES OF CHILDREN. Sixth edition, revised and augmented. In one octavo volume of 779 pages. Cloth, $5.25; leather, $6.25.

TIDY, CHARLES MEYMOTT, M. B., F. C. S.,

Professor of Chemistry and of Forensic Medicine and Public Health at the London Hospital, etc.

Legal Medicine. VOLUME II. Legitimacy and Paternity, Pregnancy, Abortion, Rape, Indecent Exposure, Sodomy, Bestiality, Live Birth, Infanticide, Asphyxia, Drowning, Hanging, Strangulation, Suffocation. Making a very handsome imperial octavo volume of 529 pages. Cloth, $6.00; leather, $7.00.

VOLUME I. Containing 664 imperial octavo pages, with two beautiful colored plates. Cloth, $6.00; leather, $7.00.

The satisfaction expressed with the first portion of this work is in no wise lessened by a perusal of the second volume. We find it characterized by the same fulness of detail and clearness of expression which we had occasion so highly to commend in our former notice, and which render it so valuable to the medical jurist. The copious tables of cases appended to each division of the subject, must have cost the author a prodigious amount of labor and research, but they constitute one of the most valuable features of the book, especially for reference in medico-legal trials.—*American Journal of the Medical Sciences*, April, 1884.

TAYLOR, ALFRED S., M. D.,

Lecturer on Medical Jurisprudence and Chemistry in Guy's Hospital, London.

A Manual of Medical Jurisprudence. Eighth American from the tenth London edition, thoroughly revised and rewritten. Edited by JOHN J. REESE, M. D., Professor of Medical Jurisprudence and Toxicology in the University of Pennsylvania. In one large octavo volume of 937 pages, with 70 illustrations. Cloth, $5.00; leather, $6.00; half Russia, raised bands, $6.50.

The American editions of this standard manual have for a long time laid claim to the attention of the profession in this country; and the eighth comes before us as embodying the latest thoughts and emendations of Dr. Taylor upon the subject to which he devoted his life with an assiduity and success which made him *facile princeps* among English writers on medical jurisprudence. Both the author and the book have made a mark too deep to be affected by criticism, whether it be censure or praise. In this case, however, we should only have to seek for laudatory terms.—*American Journal of the Medical Sciences*, Jan. 1881.

This celebrated work has been the standard authority in its department for thirty-seven years, both in England and America, in both the professions which it concerns, and it is improbable that it will be superseded in many years. The work is simply indispensable to every physician, and nearly so to every liberally-educated lawyer, and we heartily commend the present edition to both professions.—*Albany Law Journal*, March 26, 1881.

By the Same Author.

The Principles and Practice of Medical Jurisprudence. Third edition. In two handsome octavo volumes, containing 1416 pages, with 188 illustrations. Cloth, $10; leather, $12. *Just ready.*

For years Dr. Taylor was the highest authority in England upon the subject to which he gave especial attention. His experience was vast, his judgment excellent, and his skill beyond cavil. It is therefore well that the work of one who, as Dr. Stevenson says, had an "enormous grasp of all matters connected with the subject," should be brought up to the present day and continued in its authoritative position. To accomplish this result Dr. Stevenson has subjected it to most careful editing, bringing it well up to the times.—*American Journal of the Medical Sciences*, Jan. 1884.

By the Same Author.

Poisons in Relation to Medical Jurisprudence and Medicine. Third American, from the third and revised English edition. In one large octavo volume of 788 pages. Cloth, $5.50; leather, $6.50.

PEPPER, AUGUSTUS J., M. S., M. B., F. R. C. S.,

Examiner in Forensic Medicine at the University of London.

Forensic Medicine. In one pocket-size 12mo. volume. *Preparing.* See *Students' Series of Manuals*, page 4.

LEA, HENRY C.

Superstition and Force: Essays on The Wager of Law, The Wager of Battle, The Ordeal and Torture. Third revised and enlarged edition. In one handsome royal 12mo. volume of 552 pages. Cloth, $2.50.

This valuable work is in reality a history of civilization as interpreted by the progress of jurisprudence. . . In "Superstition and Force" we have a philosophic survey of the long period intervening between primitive barbarity and civilized enlightenment. There is not a chapter in the work that should not be most carefully studied; and however well versed the reader may be in the science of jurisprudence, he will find much in Mr. Lea's volume of which he was previously ignorant. The book is a valuable addition to the literature of social science.—*Westminster Review*, Jan. 1880.

By the Same Author.

Studies in Church History. The Rise of the Temporal Power—Benefit of Clergy—Excommunication. New edition. In one very handsome royal octavo volume of 605 pages. Cloth, $2.50. *Just ready.*

The author is pre-eminently a scholar. He takes up every topic allied with the leading theme, and traces it out to the minutest detail with a wealth of knowledge and impartiality of treatment that compel admiration. The amount of information compressed into the book is extraordinary. In no other single volume is the development of the primitive church traced with so much clearness, and with so definite a perception of complex or conflicting sources. The fifty pages on the growth of the papacy, for instance, are admirable for conciseness and freedom from prejudice.—*Boston Traveller*, May 3, 1883.

Allen's Anatomy	6
American Journal of the Medical Sciences	3
American Systems of Gynecology	27
American System of Practical Medicine	15
An American System of Dentistry	24
*Ashhurst's Surgery	20
Ashwell on Diseases of Women	28
Attfield's Chemistry	9
Ball on the Rectum and Anus	4, 21
Barker's Obstetrical and Clinical Essays,	29
Barlow's Practice of Medicine	17
Barnes' Midwifery	29
*Barnes on Diseases of Women	27
Barnes' System of Obstetric Medicine	29
Bartholow on Electricity	17
Basham on Renal Diseases	24
Bell's Comparative Physiology and Anatomy	4, 7
Bellamy's Operative Surgery	4, 20
Bellamy's Surgical Anatomy	6
Blandford on Insanity	19
Bloxam's Chemistry	9
*Bristowe's Practice of Medicine	14
Broadbent on the Pulse	4, 17
Browne on the Ophthalmoscope	23
Browne on the Throat	18
Bruce's Materia Medica and Therapeutics	11
Brunton's Materia Medica and Therapeutics	11
Bryant on the Breast	4, 21
*Bryant's Practice of Surgery	21
*Bumstead on Venereal Diseases	25
*Burnett on the Ear	23
Butlin on the Tongue	4, 21
Carpenter on the Use and Abuse of Alcohol	8
*Carpenter's Human Physiology	8
Carter & Frost's Ophthalmic Surgery	4, 23
Century of American Medicine	14
Chambers on Diet and Regimen	17
Charles' Physiological and Pathological Chem.	10
Churchill on Puerperal Fever	28
Clarke and Lockwood's Dissectors' Manual	4, 6
Classen's Quantitative Analysis	10
Cleland's Dissector	5
Clouston on Insanity	19
Clowes' Practical Chemistry	10
Coats' Pathology	13
Cohen on the Throat	18
Coleman's Dental Surgery	24
Condie on Diseases of Children	30
Cornil on Syphilis	25
*Cornil and Ranvier's Pathological Histology	13
Cullerier's Atlas of Venereal Diseases	25
Curnow's Medical Anatomy	4, 6
Dalton on the Circulation	7
*Dalton's Human Physiology	8
Davis' Clinical Lectures	17
Draper's Medical Physics	7
Druitt's Modern Surgery	20
Duncan on Diseases of Women	28
*Dunglison's Medical Dictionary	4
Edes' Materia Medica and Therapeutics	12
Edis on Diseases of Women	27
Ellis' Demonstrations of Anatomy	7
Emmet's Gynæcology	28
*Erichsen's System of Surgery	21
Esmarch's Early Aid in Injuries and Accid'ts	24
Farquharson's Therapeutics and Mat. Med.	12
Fenwick's Medical Diagnosis	16
Finlayson's Clinical Diagnosis	16
Flint on Auscultation and Percussion	18
Flint on Phthisis	18
Flint on Physical Exploration of the Lungs	18
Flint on Respiratory Organs	18
Flint on the Heart	18
Flint's Essays	18
*Flint's Practice of Medicine	14
Folsom's Laws of U. S. on Custody of Insane	19
Foster's Physiology	8
*Fothergill's Handbook of Treatment	16
Fothergill on Mind and Liver	16
Fownes' Elementary Chemistry	9
Fox on Diseases of the Skin	26
Frankland and Japp's Inorganic Chemistry	9
Fuller on the Lungs and Air Passages	18
Galloway's Analysis	8
Gibney's Orthopædic Surgery	20
Gould's Surgical Diagnosis	4, 20
*Gray's Anatomy	5
Greene's Medical Chemistry	10
Green's Pathology and Morbid Anatomy	13
Griffith's Universal Formulary	11
Gross on Foreign Bodies in Air-Passages	18
Gross on Impotence and Sterility	25
Gross on Urinary Organs	25
*Gross' System of Surgery	20
Habershon on the Abdomen	16
*Hamilton on Fractures and Dislocations	22
Hamilton on Nervous Diseases	19
Hartshorne's Anatomy and Physiology	6
Hartshorne's Conspectus of the Med. Sciences	3
Hartshorne's Essentials of Medicine	14
Hartshorne's Household Medicine	17
Hermann's Experimental Pharmacology	11
Hill on Syphilis	25
Hillier's Handbook of Skin Diseases	26
Hoblyn's Medical Dictionary	4
Hodge on Women	28
Hodge's Obstetrics	28
Hoffmann and Power's Chemical Analysis	10
Holden's Landmarks	5
Holland's Medical Notes and Reflections	17
*Holmes' System of Surgery	22
Horner's Anatomy and Histology	6
Hudson on Fever	4
Hutchinson on Syphilis	4, 25
Hyde on the Diseases of the Skin	26
Jones (C. Handfield) on Nervous Disorders	19
Juler's Ophthalmic Science and Practice	23
King's Manual of Obstetrics	29
Klein's Histology	4, 13
Landis on Labor	30
La Roche on Pneumonia, Malaria, etc.	15
La Roche on Yellow Fever	14
Laurence and Moon's Ophthalmic Surgery	22
Lawson on the Eye, Orbit and Eyelid	23
Lea's Studies in Church History	31
Lea's Superstition and Force	31
Lee on Syphilis	25
Lehmann's Chemical Physiology	8
*Leishman's Midwifery	30
Lucas on Diseases of the Urethra	4, 24
Ludlow's Manual of Examinations	3
Lyons on Fever	14
Maisch's Organic Materia Medica	11
Marsh on the Joints	4, 22
May on Diseases of Women	28
Medical News	1
Medical News Visiting List	3
Medical News Physicians' Ledger	3
Meigs on Childbed Fever	28
Miller's Practice of Surgery	20
Miller's Principles of Surgery	20
Mitchell's Nervous Diseases of Women	19
Morris on Diseases of the Kidney	4, 24
Morris on Skin Diseases	26
Neill and Smith's Compendium of Med. Sci.	3
Nettleship on Diseases of the Eye	23
Norris and Oliver on the Eye	23
Owen on Diseases of Children	4, 30
*Parrish's Practical Pharmacy	11
Parry on Extra-Uterine Pregnancy	28
Parvin's Midwifery	29
Pavy on Digestion and its Disorders	17
Pepper's System of Medicine	15
Pepper's Forensic Medicine	4, 31
Pepper's Surgical Pathology	4, 13
Pick on Fractures and Dislocations	4, 22
Pirrie's System of Surgery	20
Playfair on Nerve Prostration and Hysteria	19
*Playfair's Midwifery	29
Politzer on the Ear and its Diseases	24
Power's Human Physiology	4, 8
Purdy on Bright's Disease and Allied Affections	24
Ralfe's Clinical Chemistry	4, 10
Ramsbotham on Parturition	28
Remsen's Theoretical Chemistry	9
*Reynolds' System of Medicine	14
Richardson's Preventive Medicine	17
Roberts on Urinary Diseases	24
Roberts' Compend of Anatomy	7
Roberts' Principles and Practice of Surgery	20
Robertson's Physiological Physics	4, 7
Ross on Nervous Diseases	19
Savage on Insanity, including Hysteria	4, 19
Schäfer's Essentials of Histology,	13
Schreiber on Massage	17
Seiler on the Throat, Nose and Naso-Pharynx	18
Series of Clinical Manuals	4
Simon's Manual of Chemistry	9
Skey's Operative Surgery	20
Slade on Diphtheria	18
Smith (Edward) on Consumption	18
*Smith (J. Lewis) on Children	30
Smith's Operative Surgery	22
Stillé on Cholera	16
*Stillé & Maisch's National Dispensatory	12
*Stillé's Therapeutics and Materia Medica	12
Stimson on Fractures	22
Stimson's Operative Surgery	22
Stokes on Fever	14
Students' Series of Manuals	4
Sturges' Clinical Medicine	17
Tanner on Signs and Diseases of Pregnancy	29
Tanner's Manual of Clinical Medicine	16
Taylor on Poisons	31
*Taylor's Medical Jurisprudence	31
Taylor's Prin. and Prac. of Med. Jurisprudence	31
*Thomas on Diseases of Women	27
Thompson on Stricture	24
Thompson on Urinary Organs	24
Tidy's Legal Medicine	31
Todd on Acute Diseases	17
Treves' Manual of Surgery	21
Treves' Surgical Applied Anatomy	4, 6
Treves on Intestinal Obstruction	4, 21
Tuke on the Influence of Mind on the Body	19
Visiting List, The Medical News	3
Walshe on the Heart	18
Watson's Practice of Physic	14
*Wells on the Eye	23
West on Diseases of Childhood	30
West on Diseases of Women	27
West on Nervous Disorders in Childhood	30
Williams on Consumption	18
Wilson's Handbook of Cutaneous Medicine	26
Wilson's Human Anatomy	6
Winckel on Pathol. and Treatment of Childbed	28
Wöhler's Organic Chemistry	8
Woodhead's Practical Pathology	13
Year-Books of Treatment for 1884 and 1885	17

Books marked * are also bound in half Russia.

LEA BROTHERS & CO., Philadelphia.

LANE MEDICAL LIBRARY

To avoid fine, this book should be returned on or before the date last stamped below.

M32 Smith, S. 5625
S66 The principles and prac-
1887 tice of operative
surgery

NAME	DATE DUE